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the tech engineering news

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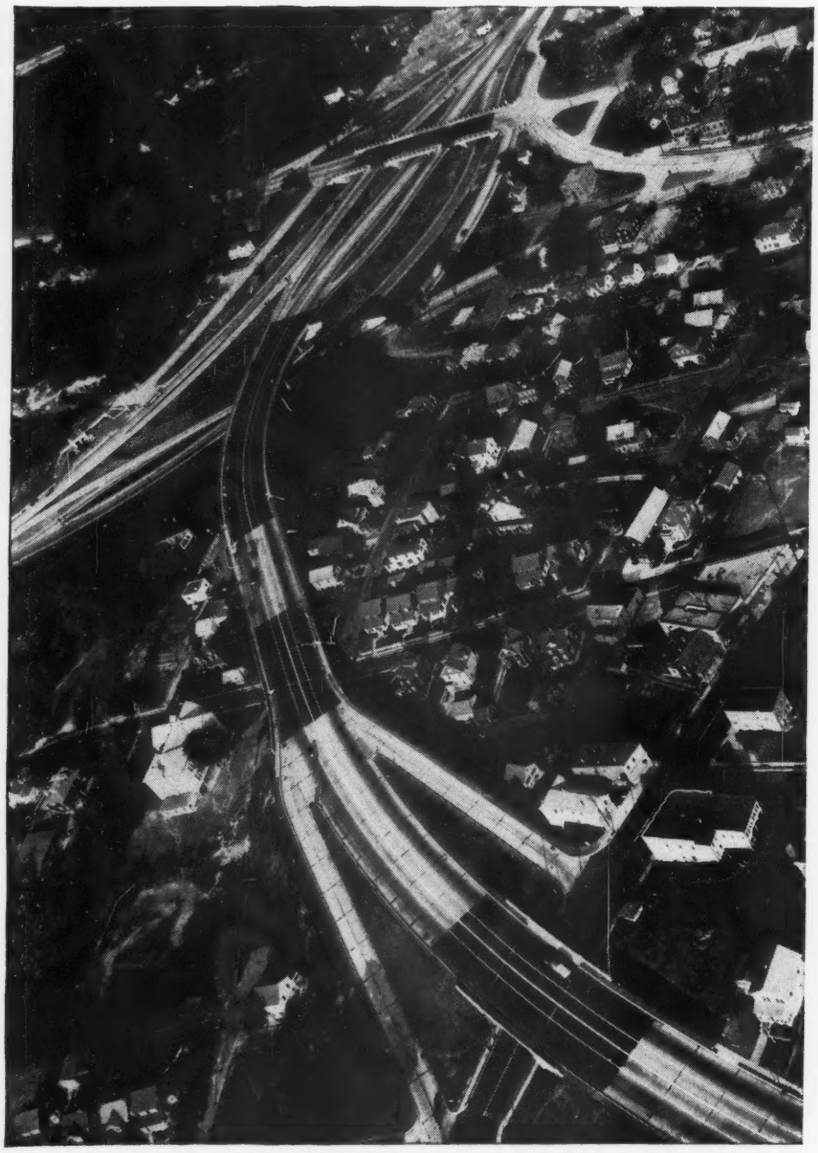
"...just drive straight ahead for 37,681 miles"



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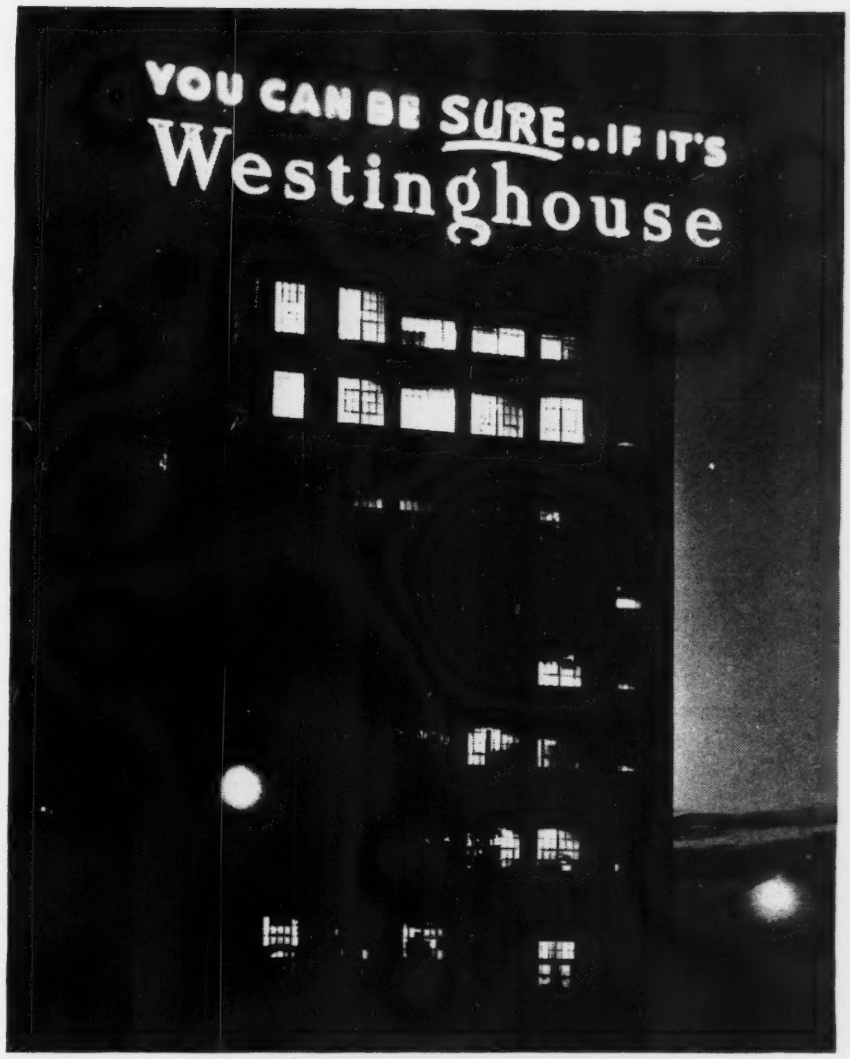

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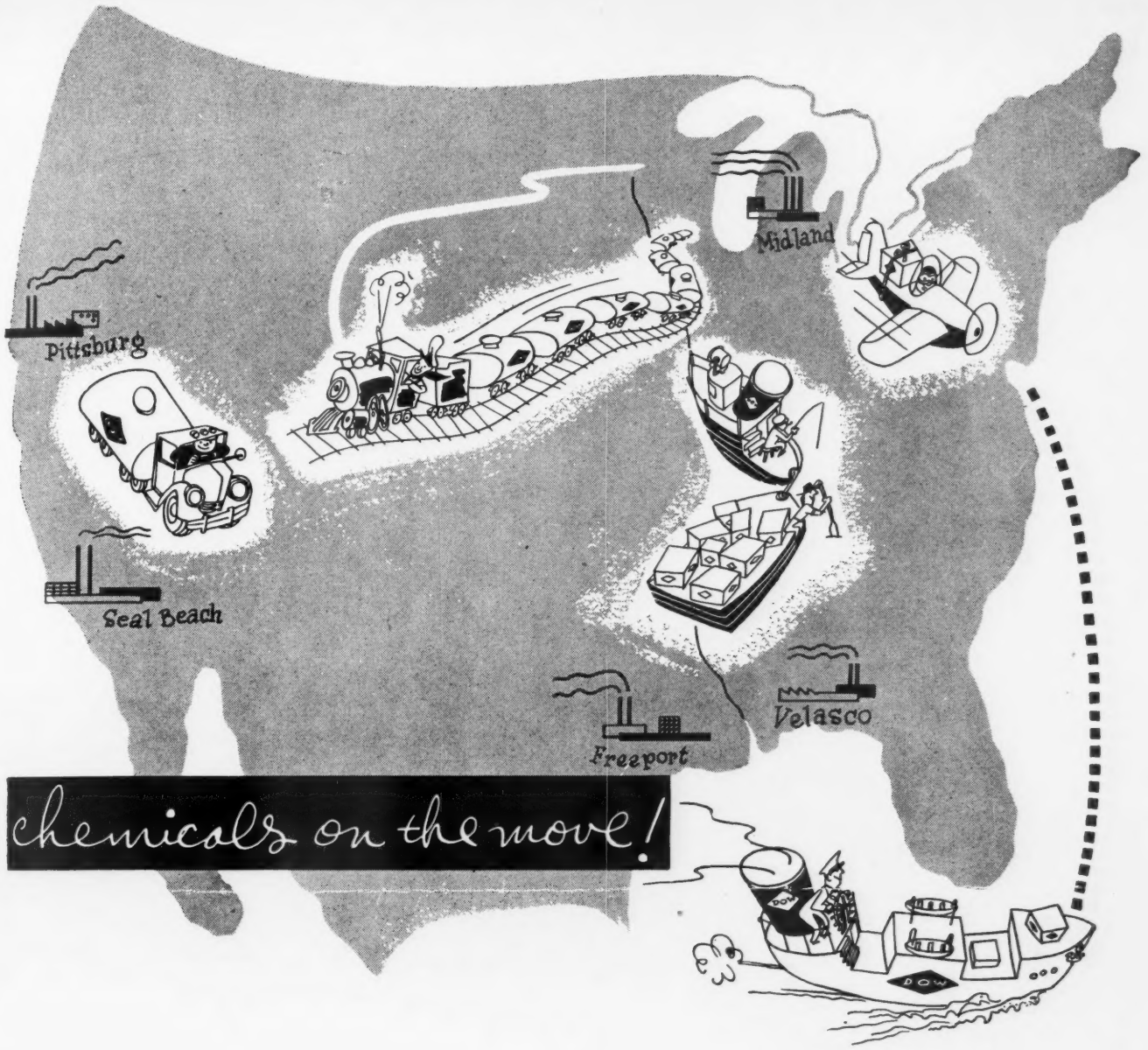

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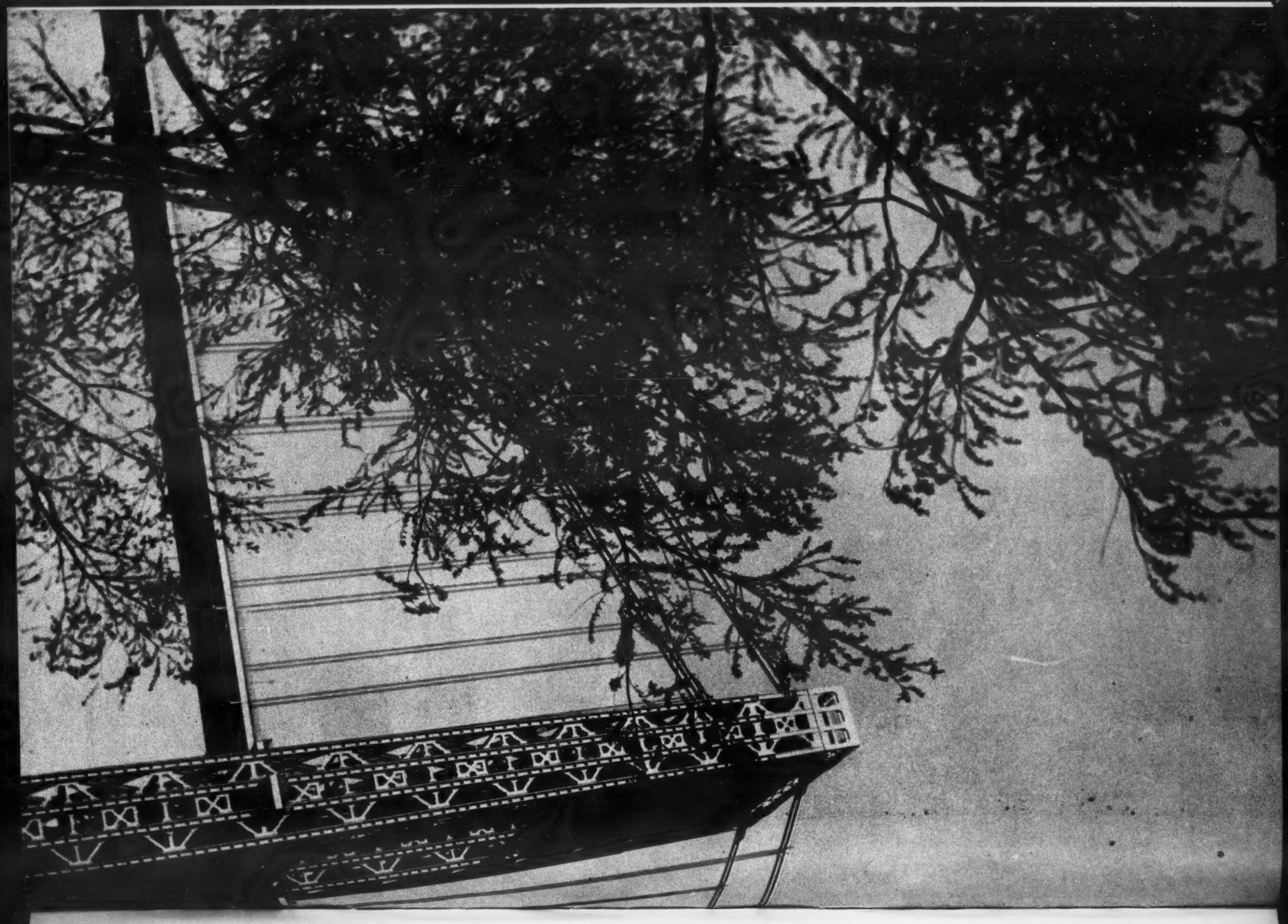

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power packages

By Henry R. Jex, '51

The diminutive racing plane which a moment before had been roaring around its course was landed. The spectators crowded about to see if a speed record had been broken. Word came through — for the eight laps over which the plane was timed, it averaged over 160 miles per hour. Yet the "racing airplane" had only a two-foot wing span, and the engine weighed *one pound!* The "pilot" stood in the center of a 150-foot circle and by means of thin steel wires, kept it flying the circular course safely and controlled the take-off and landing. For a forty-foot prototype to compare with this two-foot model, the full scale airplane would have to travel twenty times faster, or 3,200 miles per hour!

What are the "power packages" like which can pull a model around so rapidly?

Most miniature engines make use of a "two-stroke cycle," because it enables them to handle a larger quantity of fuel and air per unit time than the four-stroke cycle. Thus there is more potential power available despite the lower efficiency of two-cycle operation. Furthermore, reciprocating valves are eliminated.

It might be advantageous at this time to review the function of the two-stroke cycle. Unlike an ordinary automobile engine (four-cycle), the two-cycle engines use the volumes above *and* below the piston to assist in the flow of the fuel-air mixture. Now, four things happen to a fuel-air charge entering any engine: it must be put into the combustion chamber, compressed, fired, and finally ejected when its energy is spent. In a two-cycle engine, two things happen simultaneously. Let's start with the piston at the bottom of its stroke and move it upwards, following the process through. Because the engine has been "primed" with a few drops of fuel above the piston, there is fuel-air vapor trapped in the cylinder head, and as the piston moves up, this vapor is compressed to about one-tenth its original volume. At the same time the piston is forming a partial vacuum in the crankcase below, which is still sealed off. But just as the piston nears the top of its stroke, a hole is uncovered somewhere in the crankcase, and air rushes in to relieve the partial vacuum, bringing with it some atomized fuel from the carburetor. As things now stand, we have a cylinder head full of compressed mixture and a crankcase also full of the uncompressed mixture. The idea is to fire the compressed charge, make use of its power on the down stroke, and still get the crankcase mixture up into the cylinder before the piston starts up again.

The charge is fired (one way or another, as will be discussed later) and its expansion gives power to the shaft as the piston travels down. But the hole which let the mixture into the crankcase is closed again so that the trapped material under the piston is compressed. However, just as the piston reaches the bottom of its stroke, two "ports" on opposite sides of the cylinder are uncovered, one to the outside and one to the crankcase. The compressed crankcase mixture is allowed to pass through the "bypass" to fill the cylinder as the burned gases rush out through the exhaust port. The four requirements of intake, compression, firing, and exhaust have thus been accomplished in only two strokes or one revolution; this cycle is repeated continuously.

Going back to that "uncovered hole" in the crankcase through which the fuel is admitted, we come to a consideration of "valving." The simplest way to uncover a port at the top of the stroke is to have the piston uncover a slot in the cylinder wall as in the bypass and exhaust processes. Since the piston has depth, this intake port can be uncovered by the bottom of the piston while the exhaust port directly above it remains covered, and *vice versa*. This method is called "sideport" or "three-port" valving and was used on nearly all of the pre-war engines. Development of superior fuels and ignition methods made higher r.p.m. imperative, but it was found that sideporting would not give good efficiency at high speeds. Consequently "rotary" valves came into use and are now replacing sideports in all types of engines.

Rotary valves make use of either a hollow crankshaft or a rotating disk in the rear of the crankcase. In both cases, a hole in the shaft or disk uncovers the intake tube once per revolution, the timing being determined by the position of the hole, and the duration of opening is governed by its size and shape. Because the disk valve is larger than the shaft type, larger openings for shorter periods are permitted, all of which is favorable for efficiency, but the disk must be carefully fitted so that it is air-tight yet rotates freely. Consequently their use is restricted to larger, high performance engines, while shaft rotary valves are commonly used on the smallest engines made. All three kinds of valving are pictured in figure 1.

To make use of the inertia forces of the gas moving in the intake tube, rotary valves are usually kept open even after the piston has started to compress the crankcase volume. Unfortunately, this arrangement makes for uneven running at low speeds and difficult starting,

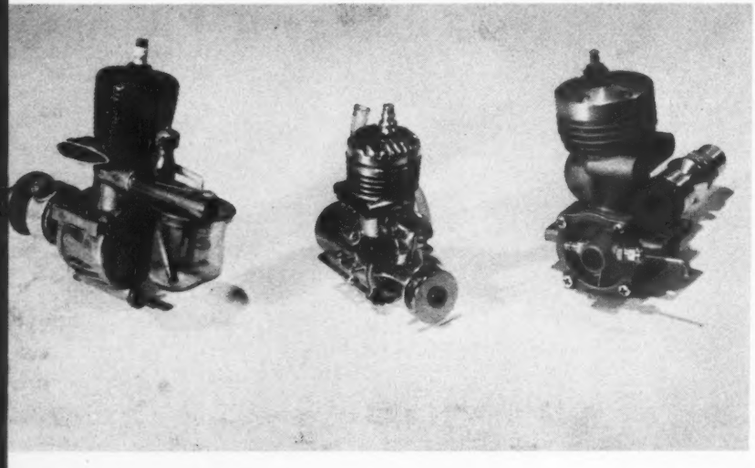


Figure 1

Three types of valving in model plane engines are represented here: "Ohlsson 23" — sideport, "McCoy .09" — shaft rotary, "Dooling 29" — disk rotary.

so old auto-generators hooked up to act as high-speed motors are used by some flyers to turn the engines over at 1,000–3,000 r.p.m. until they start. Even then there is quite a jump as the engine takes hold, for they run at 8,000–18,000 r.p.m.!

What are the different methods of firing the compressed charge? Primarily there is that old stand-by, the spark plug. The high voltage required to get a

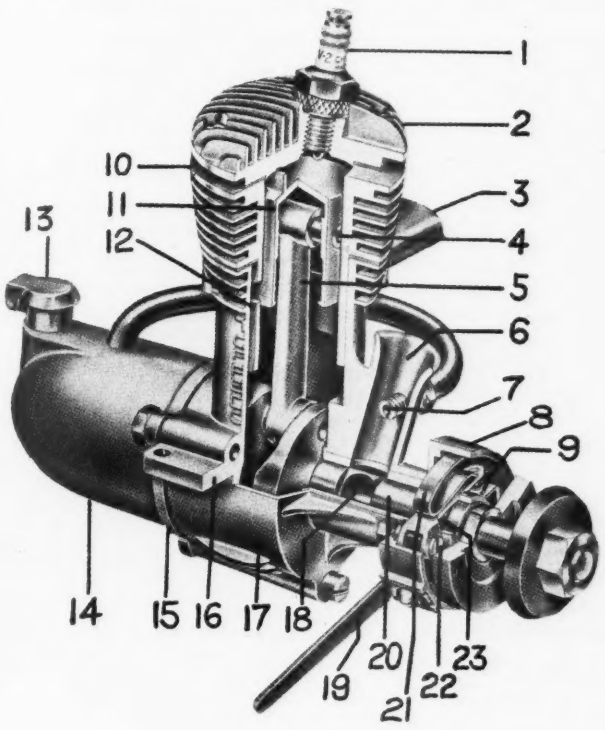


Figure 2

1. Inclined Spark Plug
2. Cylinder Head
3. Exhaust Stack
4. Wrist Pin
5. Connecting Rod
6. Intake Tube
7. Carburetor Needle Valve
8. Timer Housing
9. Breaker Points
10. Cylinder
11. Piston
12. Bypass
13. Filter Cap
14. Gas Tank
15. Rear Crankcase Cover
16. Mounting Lug
17. Crankcase
18. Rotary Valve
19. Timer Arm
20. Crankshaft
21. Breaker Point Spring
22. Point Adjusting Pin
23. Timer Cam

good spark at high compression is usually obtained by the use of a battery-operated induction coil. A cam on the crankshaft operates breaker points to give the spark at any desired part of the cycle; the optimum is nearly 30° *before* the piston reaches top-stroke. This allows the maximum expansion energy of the gas to be utilized. In figure 4, notice the bulk of the necessary components: the box for the batteries which operate the coil, the heavy coil itself, and the breaker-point system with its capacitor. Nevertheless, spark ignition is a most flexible arrangement which permits efficient operation at a wide range of r.p.m., sometimes from 3,000 r.p.m. to over 15,000 r.p.m.

More recently, in an effort to eliminate battery bulk and improve high-speed ignition, magnetos have been tried successfully. They are little more than an induction coil energized by a rotating magnet on the crankshaft. At high speeds they are more effective than the battery-coil system. A record-breaking engine which used a magneto, with oxygen injection as well, to boost the energy in each charge of fuel. To reach 192 m.p.h., nearly *two horsepower* had to be developed by this power unit which only weighed around one and a quarter pounds complete! Oxygen under 400 pounds per square inch pressure was carried in the small tank under the rear of the wing and was allowed to seep into the intake tube.

At the other extreme of the ignition methods is "compression-ignition," often called "diesel" ignition, which uses the rise in temperature of gas being compressed to ignite itself. Two things are essential for practical operation: *high* compression ratio, and a *low* kindling temperature fuel. Considering the former, compression ratios of miniature diesels runs from 15:1 to 20:1, depending on fuel and weather conditions. The majority of diesels in Europe, where they are most popular, have a variable compression head which is simply a sliding cylinder top moved in and out with a screw. Such a compression adjuster is visible on the English Mills diesel in figure 4. Although diesels have

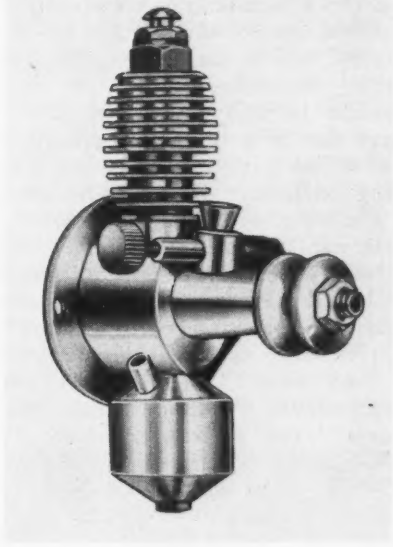


Figure 3

The K. and B. "Infant" is the smallest commercial engine in the United States. It has a displacement of .020 cubic inch.

one optimum speed, the simplicity of operation is such that it often outweighs this difficulty. The engine merely has to be fueled up, settings checked, then flipped to start. For a given fuel and its required compression ratio, the only thing which can vary is the carburetor setting. The volatile fuel will be discussed later.

An entirely new field of engine operation and design was opened when, in 1947, Ray Arden put the "glow plug" on the market. A glow plug combines the principles of external and internal ignition to fire the charge. It consists primarily of a small coil of platinum or nichrome wire inside of a spark plug-like holder, one end of the coil being grounded to the engine and the other attached to an insulated contact on top. When one and a half volts from a dry cell are connected across the contact and engine, the plug glows brightly. Using "souped-up" fuel, the engine can be started, and as soon as it is running well the battery may be disconnected, for the heat of combustion of each charge will keep it glowing for the next charge. Here is an ignition system which needs external help only in starting, but is self-sustaining thereafter. Strangely enough, there

(*Continued on page 20*)

chess and mathematics

A Study in Misunderstanding

By Harry F. Davis, G.

Of all human activities, the two most misunderstood by the uninitiated are chess and mathematics. This is not surprising, for an appreciation of either comes only through experience and study, and a complete understanding of them cannot be gained at all. In the last few years this misunderstanding has been furthered by writers who suggest the possibi'ity of constructing a mathematical machine that is able to play chess. This is an old suggestion, and is not misleading to a chess player or a mathematician, but there is much in it that is misleading to one not well acquainted with either. The purpose of this article is to direct attention to some of the more general aspects of chess and its relationship with mathematics, and to dispel, perhaps, some of the misunderstanding that exists.

Lest the reader be disappointed later, it is well to emphasize that this is neither an exposition on the applications of mathematics to chess, nor a discussion of chess-playing machines. These are narrow subjects, only parts of a more general whole. Instead, we direct attention to the parallelism that exists between mathematics and chess, which gives some insight into why people go deeply into the study of chess or mathematics.

What is chess? It is a game with a set of rules that permit a vast number of situations to occur. The chess player must react to each situation confronting him by selecting one of a number of permitted moves. This is, however, a cold approach. Better, we might say that it is an activity that is exciting and deeply moving. It can be brutal or it can be elegant. We can learn to despise a chess player by studying the way he plays; or, we can be enchanted by his daring originality.

What is mathematics? In a sense, it too is a game, but its rules are not so well defined. The mathematician may meet any situation, and he has nothing more specific to help him than the rules of logic. Like chess, mathematics can be enjoyable and stimulating. It can be as brutal as the necessity of the situation requires; its methods can be as elegant and polished as a work of sculpture. We can be entranced by the creative talent of a mathematician, or we may despise him for opposing cherished ideas. It often seems that it is no longer fashionable to look at chess and mathematics except from a dispassionate point of view. This is a great mistake. To cut emotion from mathematics is to deny a young student the temptation that may lead him to become a great mathematician (he may become a nuclear physicist instead). The player who cuts emotion from his chess will probably ensure his own defeat.

The most important single fact concerning these two activities is that they both have a history that *includes the present.* Their origins are to be found in the earliest civilizations; they both continue to develop today. It is a great error to suppose that chess and mathematics have already developed. Rather, it is well to regard both as current events, in which discoveries are yet being made, new theories yet being advanced, and in which tremendous strides have been made during the lifetime of many now living. There is much popular reading material devoted to mathematics, and perhaps more literature published in book form on chess than on any other game or sport. Yet it is rare to find a Technology student who has any idea what a mathematician does professionally except teach, and very few people know that chess, in one large modern country, is as popular today as a national pastime as is baseball in the United States. Consequently many regard these as dead subjects, thinking that they are the same today as they were fifty years ago. This assumption, so far from being correct, is the root of much misunderstanding.

It is in the recent history of chess and mathematics that we see the most striking similarity between them. To a large extent, the modern developments in both fields have been in the direction of greater generalization. To explain what is meant here by generalization, let us pause to recall the steps that each of us took in learning what we know of mathematics. We will find that close analogies exist in the steps which must be taken in learning chess.

Mathematics

The first mathematics that is learned is probably the process of counting and the idea of number. As a small child, one learns the meaning of "three" by seeing various groups of three objects, and associating the abstract number *three* with it. Anyone who has recently tried to teach numbers to a small child appreciates that this is an abstraction that is not comprehended easily. After the child has learned the first few numbers, he must learn to count to the larger numbers that are not easily visualized. Much later, he is taught the operations of addition, subtraction, multiplication, and division. The operations learned at this "stage of generalization" are mostly mechanical, i.e., definite rules can be prescribed for performing them. Such systematic methods of computation are called *algorithms.*

A second stage of development comes in the application of these algorithms to actual situations, the "word problems" of elementary arithmetic. Here it is not possible to give definite rules of procedure, and an element of ingenuity may enter into the solution of the problem.

The third level of generalization consists in learning the tools whereby some of the ingenuity involved in the second stage may be overcome by mechanical means. Thus, for example, a tricky problem is "reworded" as an algebraic equation, which may be solved by fairly definite rules.

However, the person who has taken algebra in school rarely goes deeply enough into mathematics to learn why these rules work as well as they do; he is satisfied that the methods give the correct results. The fourth stage is, therefore, that in which we pause to examine why the tools work as well as they do. Here we learn the limitations inherent in the methods learned in the third stage.

A large part of learning higher mathematics consists of a repetition of the third and fourth stages; we learn

(*Continued on page 22*)

rayons . . . custom built fibers

By O. A. Battista

Paraphrasing the quip about the acorn and the oak tree, we might say, "From little ideas giant industries grow."

The little idea from which one of the world's largest chemical industries has grown, rayon, first appeared in Robert Hooke's celebrated *Micrographia* in 1664. "I have often thought," wrote Hooke, "that there might be a way to make an artificial glutinous composition as good, nay better, than that out of which the silkworm wire-draws his clew. This hint may give some inquisitive person an occasion of making some trials. If successful, I suppose he will have no occasion to be displeased."

Mr. Battista is a member of the Chemical Research Department of American Viscose Corporation. He has been with Viscose since 1940 and has contributed technical articles to leading periodicals.

Today, versatile man-made rayon fibers are second in volume in the textile field, with the total annual production greater than wool and exceeded only by cotton. According to the latest estimates by the Textile Economics Bureau, Inc., by July 1950 the yearly capacity of the American market should exceed 1,200,000,000 pounds. Yet only forty years ago not a single pound of rayon was being manufactured in the United States.

The world has beaten a path to rayon's door because rayon has had something worthwhile to offer it. This product, the culmination of Hooke's primitive idea, has gained popular support because of its made-to-order, custom-built properties. Rayons may be manufactured to meet specified and preferred uniformity, luster, and strength. Unlike the natural fibers, they are what man's industry, ingenuity, and special needs dictate them to be.

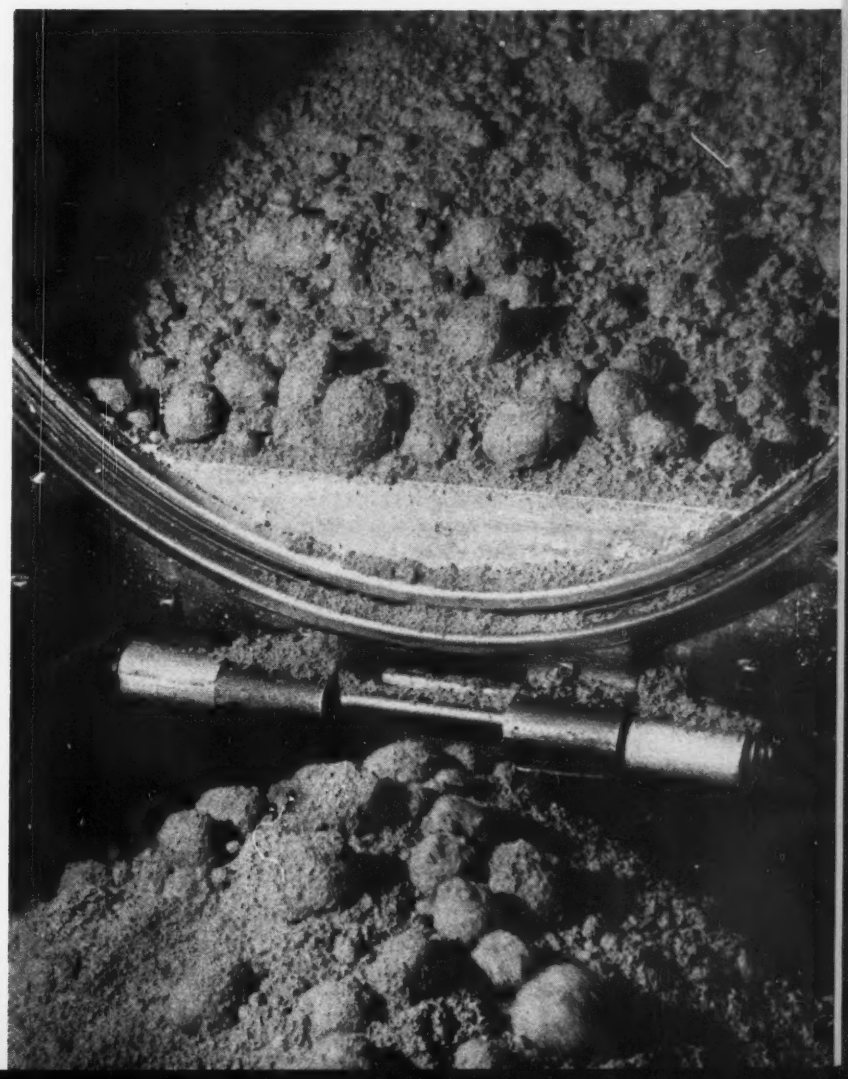
For example, from exactly the same raw materials rayons may be made that are ideal for bedecking a June bride with a tulle veil, a Juliet cap and a satiny dress with basque top and full-skirted gown. Or, by a slight twist of the process, tough, shock-resistant rayon tire cord used in heavy duty plane and truck tires is produced.

Actually, the story of the rayon industry is in keeping with the tales of the Arabian Nights. As is the case with most industrial successes, however, we can look back on it with 20/20 vision.

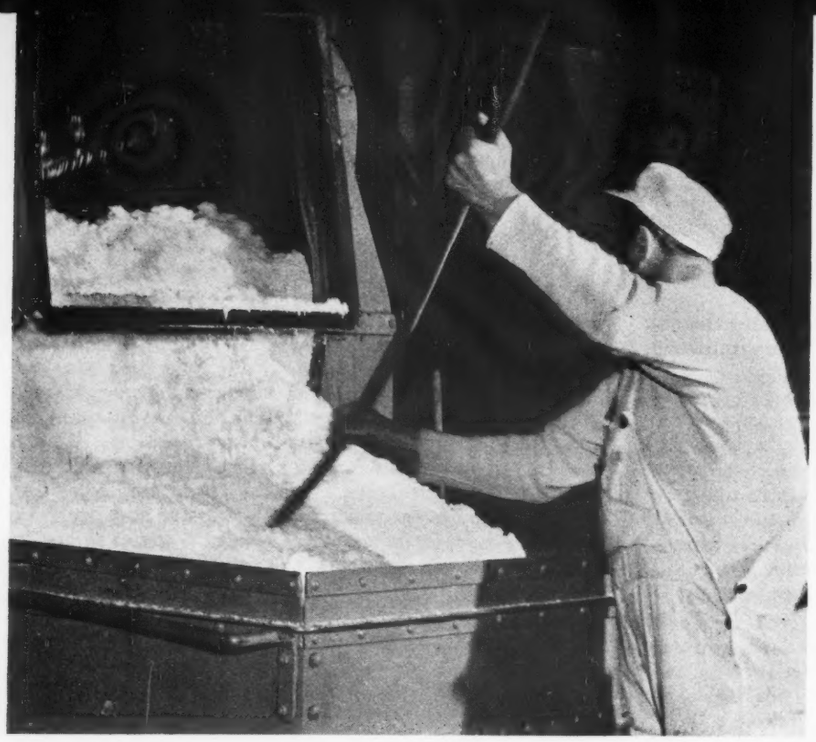
Seventy years after Hooke offered his suggestion, René de Reaumur, a French scientist, began taking a close look at spiders and silkworms in action. He set out to collect gums and resins, and test them for their fiber-making properties. But the world stage was not yet in readiness for the advent of rayon, and his work did not produce any practical results. One of the main problems of his day was the invention of a means whereby the liquid gums could be shaped and set up into continuous filaments.

Audemars, a chemist of Lausanne, Switzerland, carried on the scientific search for man-made fibers, and was granted the first patent for making "artificial silk" in 1885 in England. Alas the best he could do was to form short lengths of threads by dipping a needle into gummy solutions and drawing it out quickly, hardly a practical way of producing much poundage.

At about this time, Sir Joseph W. Swan was searching for a means of making carbon filaments for the new and exciting electric lamps. Eureka! He came upon the simple trick. He squeezed his gummy solution, collodion — a solution of guncotton or nitrocellulose, through fine holes into a coagulating bath. In this manner he was able to collect sizeable quantities of continuous fiber. After denitrating the man-made fiber by means of ammonium sulfide, and carbonizing



After ageing, the alkali cellulose crumbs are placed in mechanical churns and reacted with carbon bisulphide. Orange-colored cellulose xanthate results.



After steeping in caustic soda, the swollen cellulose sheets are crumbled by the revolving blades of a pfleidering machine.

the resulting cellulose, he used the end product successfully in electric lamps. Obviously, Swan had unlocked the door to the modern textile industry by demonstrating how to make continuous lengths of fiber. Developments moved quickly thereafter.

The central figure and pioneer in the manufacture of rayon on a commercial scale was the French chemist, Count Hilaire de Chardonnet.

During the years when Chardonnet began his first small scale experiments, he received only criticism. His friends refused to offer him the helping hand of encouragement. "He is a dreamer" they would remark. "His idea is impossible of fulfillment. Man never will be able to produce textile fibers like the silkworm's product by means of machinery."

But Chardonnet had enough built-in enthusiasm to ride the hurdles of those who took him lightly. He forged ahead alone, filled with faith, faith in himself and his ideas.

His first approach to the problem was the most obvious one. He started out with vast quantities of mulberry leaves, the raw material from which silkworms produce their silk. However, no matter how he cooked or stewed the mulberry leaves, he never was able to make a paste from which he could string out threads. Chemistry of Chardonnet's day had not advanced very far or this inventor's failures would have been reduced and his heartaches eased. It was not understood at the time that the mulberry leaves must become changed chemically in the stomachs of the silkworms into complex proteins before being spun into natural silk.

It was not until Chardonnet turned his sights on cellulose, the structural material of all plant life, that he began making headway with his "artificial silk." Following in the footsteps of Audemars and Swan, he concentrated at first on making fibers from nitrocellulose.

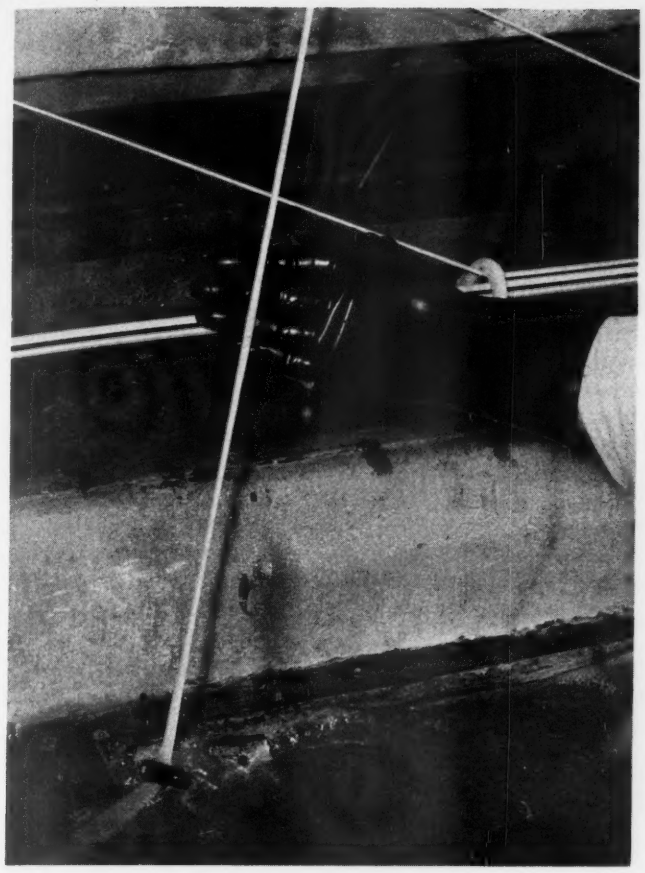
Starting with cotton, which is cellulose in one of its purest natural forms, he reacted it with a mixture of strong nitric and sulfuric acids. After washing away the acids, he dissolved the nitrocellulose in a solvent consisting of alcohol and ether and then forced the heavy, syrupy liquid through a nozzle consisting of a metal thimble the closed end of which had numerous pin-point holes punched into it.

It was 1889, the year of the Paris Exposition, when Count Hilaire de Chardonnet vindicated himself. Proudly, he displayed samples of sheer fabrics made entirely from his "artificial silk." He set up his spinning machine to demonstrate the ingenious method whereby he had succeeded in copying the silkworm's skill by mechanical means. The ladies who saw his fabrics were captivated by them. "We must have gowns and dresses made of this new kind of silk" they told their husbands, and with this support from the distaff side men eagerly invested money in his process. Soon the first commercial plant for the manufacture of rayon got under way at Besancon, France. Chardonnet had earned his title as the "Father of the Rayon Industry."

A discovery, however, was in the making that soon was to supplant nitrocellulose as the base material for the manufacture of artificial silk. Working side by side in their laboratory at Kew, near London, Charles F. Cross and E. J. Bevan one day made a mixture of cellulose, caustic soda and carbon disulphide. The cellulose changed quickly to golden yellow, and slowly to an orange color. The resulting compound dissolved in water to give a syrupy, viscous solution. Quite logically, Cross and Bevan called their solution "viscose." The most successful modern method for the manufacture of rayon had gotten its start and its name.

The viscose process was patented in 1892. As late as 1902, however, the manufacture of yarn from viscose solutions had not reached much poundage. The viscose syrup was being forced through jets or spinnerets into an acid coagulating bath, and then wound onto spools. This practice proved to be costly and time-consuming, and it resulted in the filaments being badly damaged during the handling that was required for the removal of the impurities retained after coagulation.

Then, in 1902, another idea materialized that was to stimulate the growth of the rayon industry by leaps and bounds. Charles F. Topham, an assistant working at the Kew laboratory, mounted an ordinary tin can on a spindle. As the can revolved, he dropped the end of the freshly spun yarn into it and centrifugal force did the rest. The yarn collected against the sides of the tin can and built itself up into a cake from the outside toward the center. The viscose rayon spinning



Spinnerettes are immersed in an acid bath and the freshly formed filaments are allowed to remain in the bath just long enough to set up.

bucket became a reality, and most of the rayon produced in the past several decades was spun with the aid of it.

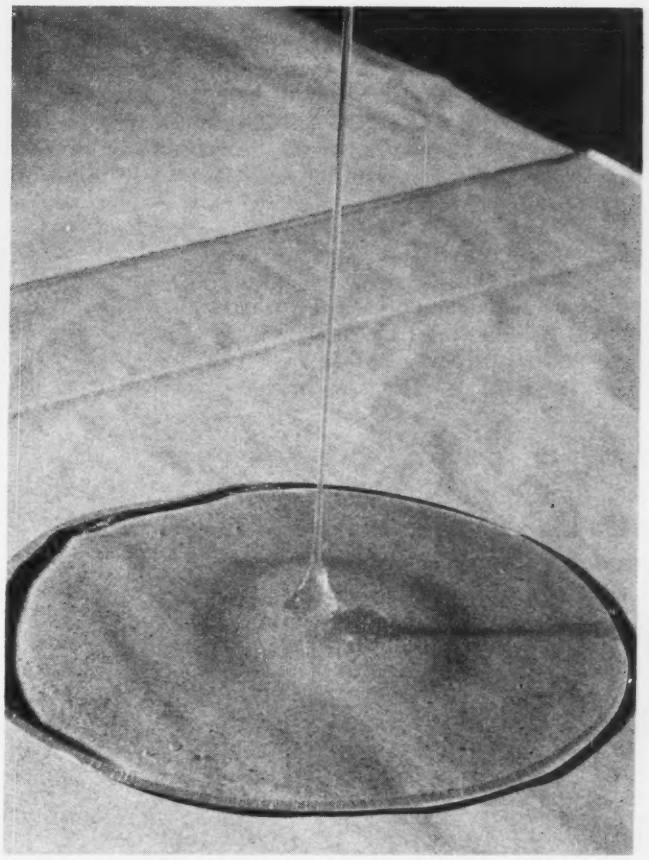
In 1904, at a time when silk still enjoyed top honors as the world's most luxurious apparel fiber, a silk weaving firm at Bocking, England stepped into the man-made fiber field. Samuel Courtauld and Company took over the Kew laboratory and the British rights to the viscose process. Their underlying object was to bring rayon to the peoples of the world, and they did just that.

By 1910, this far-seeing English firm had begun the construction of the first plant for the manufacture of viscose rayon at Marcus Hook, Pennsylvania. This plant still is running at capacity using completely renovated equipment and machinery, and along with six sister rayon plants, and one cellophane plant, it stands as the eldest member of the American Viscose Corporation's family.

Chardonnet's original nitrocellulose process no longer is used in this country. It was forced to bow out in the face of the three methods now in use for manufacturing rayons: the viscose process, the cellulose acetate process and the cuprammonium process. The viscose and cellulose acetate processes account for over 95 per cent of all rayon produced in the United States and, for this reason, mention only of these two manufacturing methods will be made here.

Although the chemistry and procedures for making rayon by the viscose process and the cellulose acetate process differ widely, the principal raw material used for making them is the same, namely, cellulose. The fundamental steps in each process, also, are the same. Cellulose is converted by means of a chemical reaction into a soluble derivative that is dissolved and spun or re-formed into solid filaments. The filaments so obtained are combined into continuous yarn, or chopped up into short lengths called "rayon staple fiber."

Solution of cellulose xanthate in caustic soda gives a reddish-orange, viscous dope.



The Viscose Rayon Process:

Highly purified cellulose, prepared from cotton fibers or wood pulp, is steeped in the form of sheets in a solution of about 18 per cent sodium hydroxide. The sodium hydroxide swells the cellulose and reacts with it to form the sodium salt of the polyhydroxy carbohydrate, and this is known usually as "alkali cellulose." The purpose of this step is to condition the cellulose or make it more highly receptive to the chemical reaction that forms the backbone of the viscose process.

After the cellulose sheets are allowed to soak in the strong caustic solution for a definite time, excess liquid is squeezed out of them by means of a hydraulic ram. The resulting moist alkali cellulose sheets, containing approximately three parts by weight of alkali to one part by weight of cellulose, next are transferred to giant shredding machines called pfleiderers. Here the swollen fibers are mechanically pulled apart into fluffy crumbs, once again with a view to increasing the chemical reactivity of the cellulose by making available as large a surface area as is practical.

When nature in her own secret way links molecules of glucose together to build up the cellulose molecule, she prefers on the average to combine between 2,000 and 3,000 molecules of glucose. It is this linking together of anhydroglucose units that makes cellulose a long chain, so-called "high" polymer, and adapts it admirably for reforming into fibers of high tensile strength.

But a solution of viscose containing cellulose molecules with 2,000 glucose united hooked together (i.e., a degree of polymerization of 2,000) gives a viscose solution that is much too viscous to handle on conventional machinery. A viscose solution with cellulose chains having about 400 to 600 glucose units joined together is preferred in commercial practice.

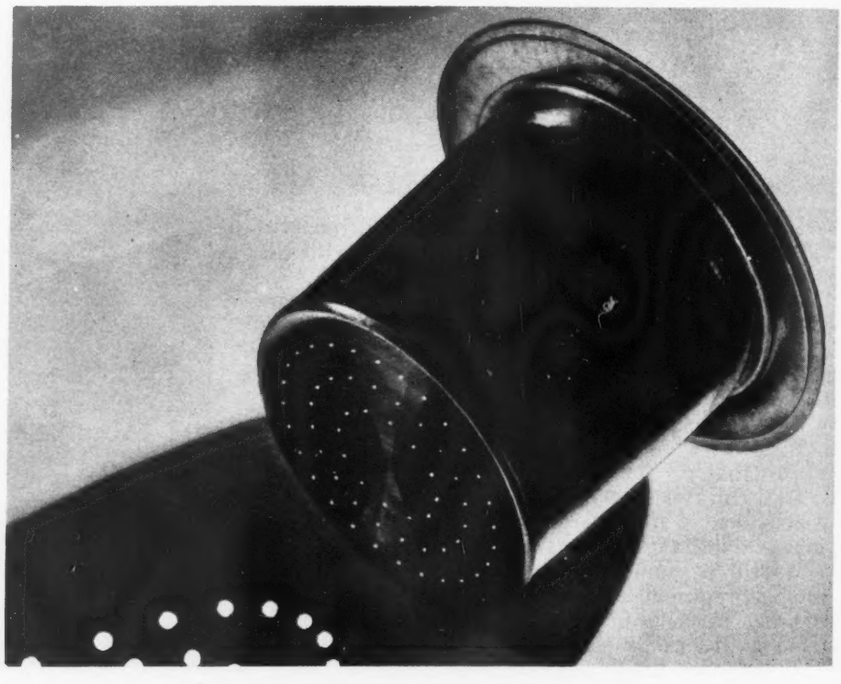
Some of the required depolymerization is performed by the pulp manufacturer during the purification of the cellulose prior to its conversion into sheet form. By the time the rayon manufacturer gets his raw material, the cellulose has a degree of polymerization of about 1,000. After the alkali crumbs are removed from the pfleiderers, the rayon manufacturer reduces the degree of polymerization still further by allowing them to "age" during which alkaline oxidation of the cellulose takes place.

Having tailored the chain length of the cellulose to the preferred degree of polymerization, the fluffy crumbs are placed in huge rotating churns. Carbon bisulphide then is blended with these crumbs under conditions of close temperature control, and an exothermic reaction takes place to produce Cross and Bevan's cellulose xanthate in the form of orange colored crumbs. This step, the xanthation reaction, usually drops the average degree of polymerization another 50 to 100 units. Everything now is ready for the preparation of the solution that will be transformed into rayon fibers. The orange colored xanthate crumbs are dumped into aqueous sodium hydroxide in huge mixers, and dissolved in this solvent.

This is a point at which it is possible to effect another tailor-making step. If the characteristic high gloss or brilliance of viscose rayon fibers is wanted, the blended solution is used without further treatment. On the other hand, if it is preferred that the final product be dull in appearance, this is achieved by adding special pigments or certain types of oil at this point. The amount of delusterant added determines the final degree of dullness.

The blended solution next is allowed to stand in large storage tanks where it undergoes a ripening or homogenizing process. At the same time, air bubbles are removed from the viscose by the application of vacuum. When the right conditions are reached that will produce a thread of optimum physical properties, the viscose solution is spun into rayon.

Swan's basic idea still is applied for this purpose. The clean, filtered viscose solution is pumped through a platinum-rhodium spinneret into an acid coagulating bath, and each hole in the spinneret forms an individual filament of yarn. From the hardening bath, the fresh-formed yarn is guided by means of guides and rotating glass wheels into a "Topham" spinning bucket. The speed of the bucket and the rate of feed of the incoming yarn is regulated so that a constant amount of twist is automatically imparted to the yarn as it is collected in cake form. The cake of yarn then is washed and purified, bleached and finished. Drying follows, after which the yarn is ready for winding into cones, skeins, tubes or other forms desired by textile mills.



The heart of rayon manufacturing is the spinneret through which the viscose solution is pumped to shape the filaments

The Cellulose Acetate Process:

Whereas the viscose process involves a chemical reaction on the alkaline side, the cellulose acetate process sticks to the acid side. Glacial acetic acid is used to swell and activate the cellulose, and then acetic anhydride is added to produce cellulose acetate. Cellulose acetate dissolves in the acetic acid as it is formed to produce a clear thick liquid. This liquid is aged, precipitated as pure white flakes by running the "acid dope" into water. The recovered flakes are washed and dried.

(*Continued on page 28*)

central says:

The room was built to house the machine. At the foot of the machine were two people, the operators. Their clothes and mannerisms were identical; their voices, calm and neutral.

"You think I'm exaggerating?" he asked.

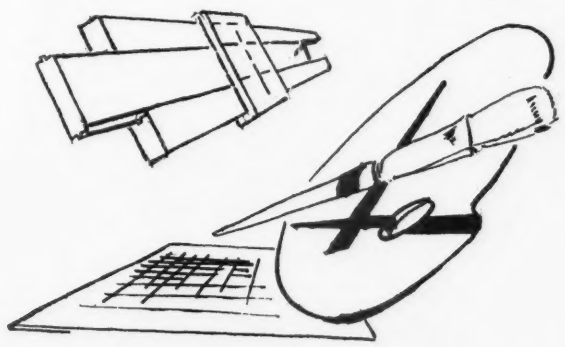
And she answered, "When you say that we were all half insane, or that half of us were all insane, I think I have a right to suspect."

"But look at the evidence. Have you ever read any of that stuff written before the crisis? Have you read Thomson's 'The Pre-Crisis Man'?"

"No, but after all — "

"Have you ever read Thomson's 'The Pre-Crisis Man'?"

"No, but — "



"Read it. And read some of the material the authors wrote in those days. You'll be surprised. Thomson isn't exaggerating and neither am I. The Pre-Crisis man was not rational, he was emotional. So completely at the hands of his emotions that his thinking was controlled by his feeling."

"You must admit it stretches the imagination."

"I know, but it's true. That's just what led to the Crisis. P.C. history hasn't been taught in the schools for two hundred years. Aside from being totally useless, it's fantastic beyond belief. You'd laugh at some of the things that our ancestors did, perhaps get disgusted. At any rate, it's diverting."

"It sounds impossible. How many minutes?"

"Seventeen, we're running slow today. But getting back to this history — I hope I'm not boring you."

"No, go on."

"Well, take love for instance."

"Love?"

"Yes, love. At least that's the way I think it's pronounced. It was one of the major — I'd even go so far as to say, the major interest of the ancients. They talked about it, they wrote about it, they groomed for it, they spent their entire lives rhapsodizing about it."

"What was it?"

"Insanity."

"Oh. Excuse me for interrupting again, but are you sure we set this thing up correctly this morning? We're way over time."

"I'm beginning to wonder about that myself. But we have no red lights yet. We might as well see what we get for results. Now where was I — oh, yes, love. They wrote reams of insane drivel. What a laugh. Love poems, love songs, love stories; everything was love, love, love."

"There's green."

"Throw seven. Now let's see what we have." He pressed the translator key and studied the tape as it unravelled in front of him. He frowned.

"Here, take a look at this."

She looked at it, smiled, and said, "It looks as though the machine were insane. Love, perhaps?"

"Very funny. Call Sherwood. Meanwhile I'll run this through again, just in case it's us and not the machine."

Half an hour later Sherwood arrived. He read the tape and smiled. "When did this begin?"

"Just this morning. John and I fed in the material and this is what came out."

Sherwood fingered the tape. "And when you ran the problem through a second time?"

"We got this." John handed him the second tape from the translator. Sherwood read a passage, referred to the first reel, compared the two, and shrugged his shoulders. "Well, well, variations on a theme."

"What do you think is wrong?"

" — Don't know yet." He walked to the phone. "But it won't take long." Sherwood dialed while the other two prepared to run the message through for the third time. He finished talking and walked back. "I've just spoken to Central and they're sending out two men to run a series of standard tests on this

machine. We should have a complete diagnosis in a few hours."

It took seven hours, and at the end of that time they had performed every test twice. The two men went back to Central and Sherwood approached John. He threw a sheaf of result papers on the control desk.

"Well?"

"We can come to only one conclusion. The machine's failure is not mechanical but functional. It is illogical, it has no rational sequence of thoughts. In short, it's become emotional."

"You see, Johnny, I told you it was love."

(*Continued on page 32*)

workshop for peace

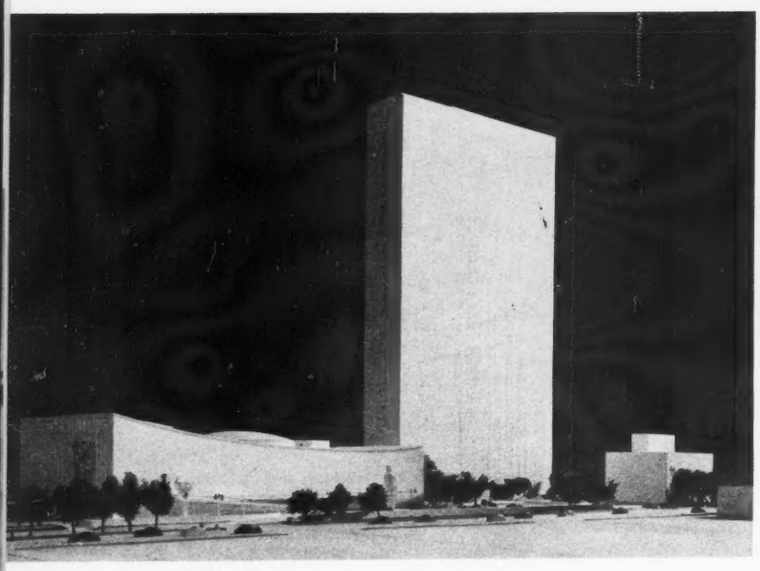
United Nations Headquarters Buildings

By Fred R. Bentel, G.

Rising at the eastern end of 42d Street in New York City is a most unique building. This latest addition to New York's skyline is and will be the object of much discussion. The permanent headquarters of the United Nations, the structure will provide shelter for the delegates and personnel of the world government. It is not surprising that such an extraordinary attempt at international unification should house itself in a building equally fresh in the solution of planning problems.

In 1946 a planning commission was established in order to begin work on permanent headquarters for the world organization. From ten member countries the U.N. drew a staff of internationally famous architects. Many site locations were considered; San Francisco, Philadelphia, and New York were the most favored locations. Although New York won the competition among the cities no exact location had been decided upon when an offer came from Mr. John D. Rockefeller, Jr. He wanted to present the U.N. with $8,500,000 which it would use to purchase the property bounded by the East River, First Avenue, 42d Street and 48th Street.

Although many believed, with Le Corbusier, that the open country, with the possibility of personnel housing on the site, would be the best scheme, the gift of the land, its relation to the East River and the fact that something had to be built immediately, made acceptance of the offer almost certain. New York, with its own population drawn from all parts of the world, was to be the new and permanent home of the global U.N.

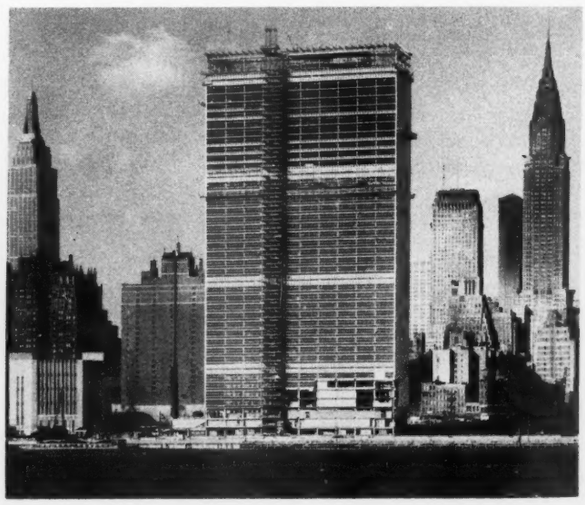


The offer accepted, the seventeen acre site was purchased. Immediately the immense task of demolishing the old slaughterhouses and warehouses on the site was begun. Both New York City and State agreed to take the U.N. property from the tax rolls. The city gave the U.N. the rights to the streets, a playground and a newly completed office building on the lot.

While demolition was under way, the planning board was translating the complex requirements of the organization into drawings. The Director of Planning and the co-ordinator of the many designers and researchers was Wallace K. Harrison, who, as the principal architect of Rockefeller Center, was well acquainted with projects of this scope. His knowledge of the site was particularly good since he had worked on plans to develop a great office and residential project there.

Bedrock of hard Manhattan Schist, the foundation which made the construction of New York's many skyscrapers possible, formed the base under the major part of the site. The rock, extending into the area under the tallest building, could withstand extremely large concentrated loads, thus eliminating initially all foundation problems.

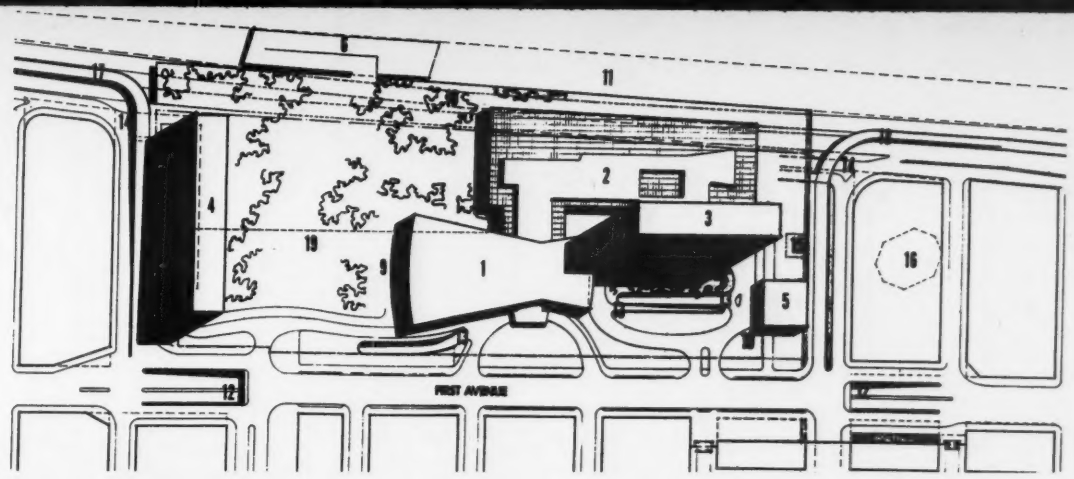
Advantages that prompted the U.N. to accept this site were to become main factors in the design of buildings. On the long side of the site is the open expanse of the East River. This meant that, though the final buildings would be part of the city pattern, they could be sure of no interference from at least one side. Sun would play an important part in the buildings' positioning. A requirement of the planning committee was that every office should receive some sunlight during the day and that major spaces should take advantage of the view of the East River. This made

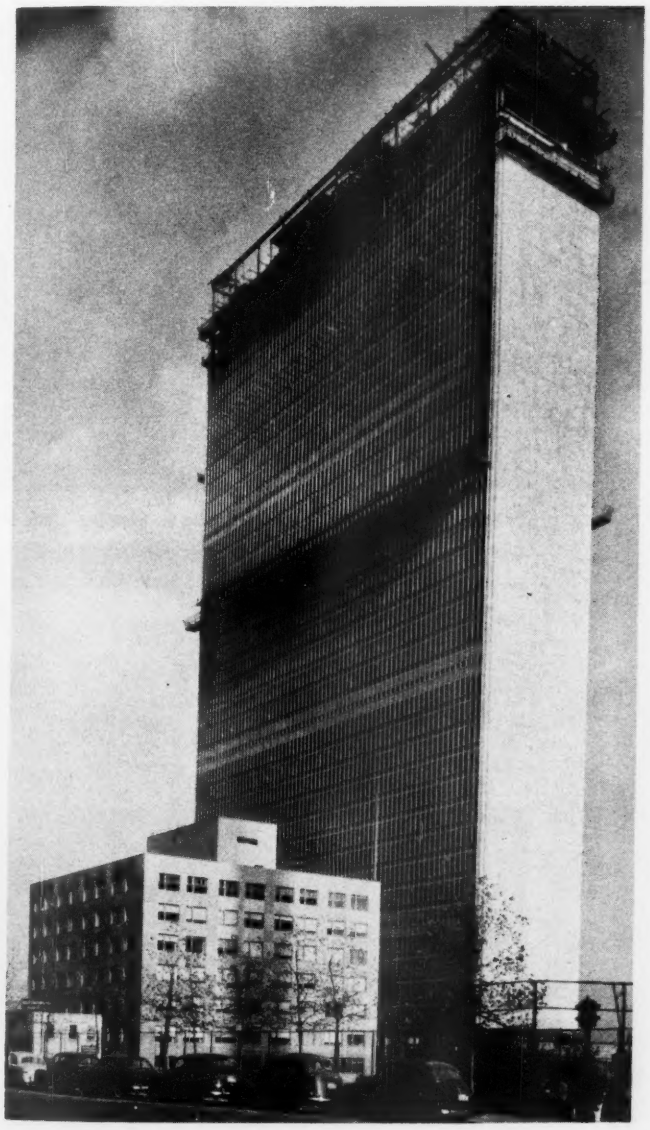


This photo shows an approved model of the permanent headquarters of the United Nations.

Viewed from the East River, the United Nations headquarters is seen against the Manhattan skyline.

1. General Assembly
2. Conference Area
3. Secretariat Building (Photo below)
4. Reserved for Delegates and special agencies
5. Building of N.Y.C. Housing Authority
6. Pier
7. Secretariat and Press entrance
8. Delegates' Entrance
9. Public Entrance
10. F. D. Roosevelt Drive underpass
11. East River
12. First Avenue underpass
13. Ramps to garage





an east-west orientation, with the long axis of the building running north and south and window areas facing east and west. Since the Secretariat would be a tall structure (thirty-nine stories) and would be located at the southern end of the site near 42d Street, it would cast an enormous shadow. Therefore a wide building across the lot would throw the remainder of the lot into continuous shadow. The lower buildings containing the assembly and conference rooms were to be placed in the middle of the site and form an open space which becomes an important plaza or focal point of the building group. As reasonable as this method of solution may seem, it has rarely been applied before.

Three distinct types of use had to be separated; delegates and workers, public and press, pedestrian and vehicular traffic. The noise, smoke and danger of First Avenue traffic were to be alleviated by directing the traffic through a tunnel under the street. Since the delegates will arrive in large numbers immediately before and after meetings by official cars and taxis, their entrance will be separate from personnel arriving in their own cars. Underground parking spaces will be provided for with direct access into the building. Delivery and truck receiving points will also be underground.

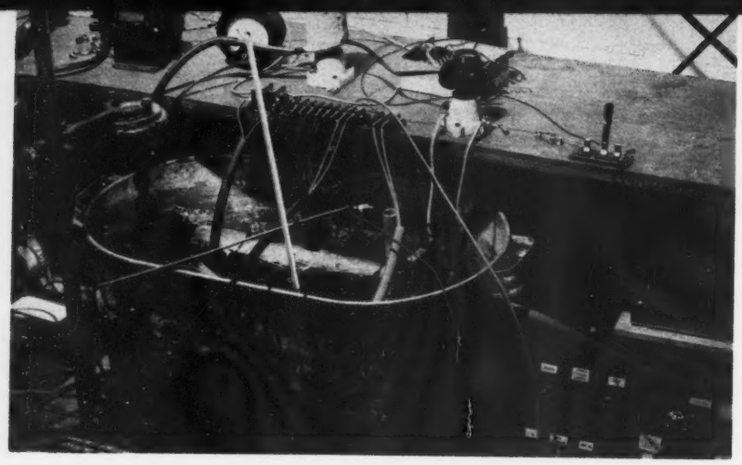
Visitors will be led directly to the galleries of the conference rooms with completely separate circulation halls and gathering spaces. Vertical circulation will be accomplished by twenty-one high-speed elevators located centrally in the Secretariat building. On the lower floors, where use will be particularly heavy, eight glass-enclosed escalators have been provided.

Such a new organization as the U.N. must, of necessity, demand one very important consideration in overall planning, flexibility. Since the space requirements, and in fact the whole organization, will change as the years go by, the building must be flexible enough to accommodate change. A standardization of parts, particularly in the office bays, permits such flexibility. If a large office space, used for a once functioning committee, is needed, the modular walls, which can be slipped into place at regular intervals, subdivide it into smaller areas. Partitions can be moved about to form new office dimensions.

The group of buildings will house the records, give space to innumerable committees and provide room for delegates to work and hear each other. The area must also act as the delegates' home and provide the rest and relaxation necessary to persons working under great stress, far from home. Thus, beyond any desire for luxurious living, there is a definite psychological necessity for the restaurants, gym facilities, libraries, and clubrooms which have been planned. Again, advantage has been taken of the East River site, since restaurant and lounge areas are all oriented to that view. Roof-top areas of low buildings are used as landscaped terraces and these, in conjunction with the extensive park-like planted areas on the ground level, will form a man-made plateau of green over subterranean areas for parking, service, and utilities from which the Secretariat rises.

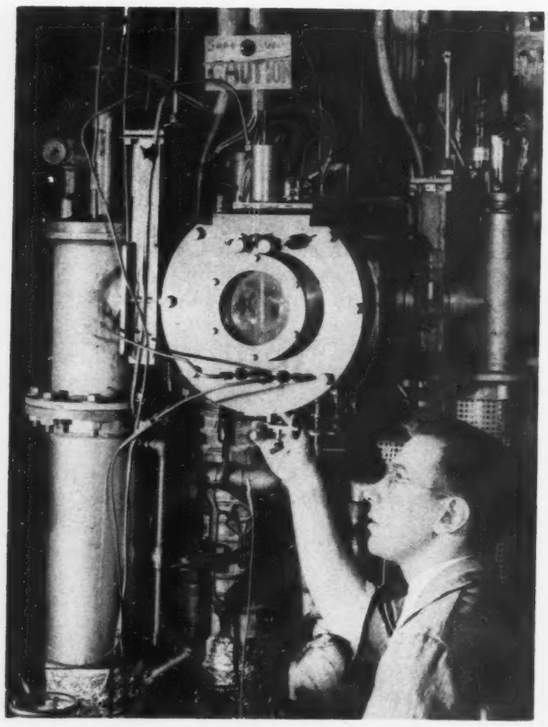
Light, artificial and natural, becomes one of the prime technical factors in the design of the buildings. Beyond the elementary principle that every office should receive some sunlight, lay the question of how much light and of what type. Since natural light has physical and psychological properties nearly impossible to duplicate, it was decided to attempt to light all work space with natural light. This resulted in the narrow, slab-like form of the building. Natural light

(*Continued on page 34*)

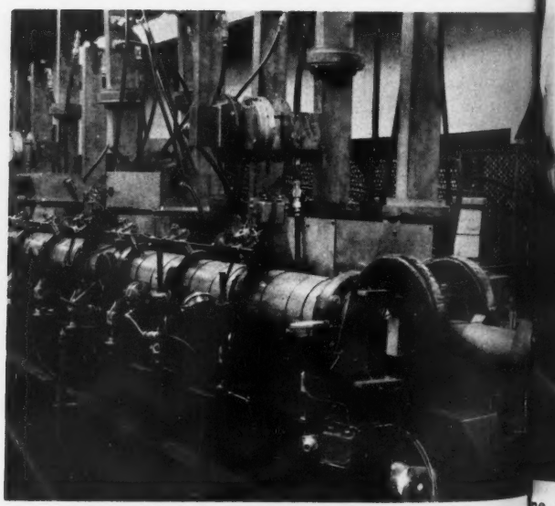


Depicted above is a set-up for studying the phenomena of low pressure arc discharges by means of tantalum probes.

Members of the Cosmic Ray Group (of the Laboratory for Nuclear Science and Engineering) prepare to launch instrument-carrying balloons into the stratosphere.



The atomic beam resonance apparatus is one of the most valuable devices used to study the magnetic properties of the atomic nucleus.



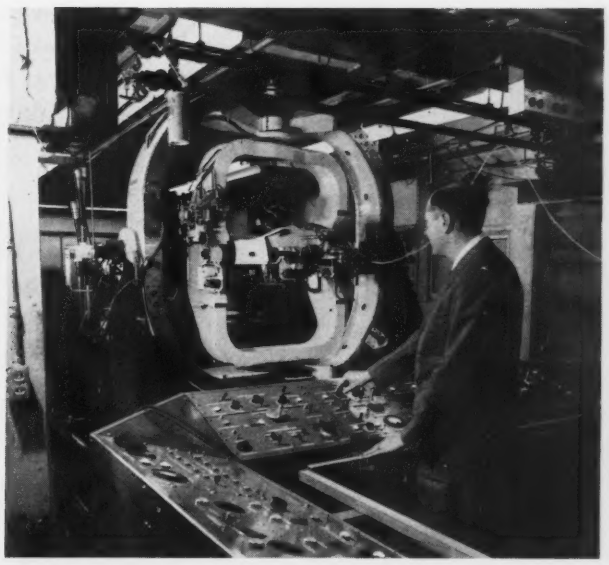
A Van de Graaf generator maintains a constant electr static field in the linear accelerator above.

RESEARCH HEAVEN

perimental broadcast studio in the Acoustics Laboratory. The lab is der the joint direction of the Electrical Engineering, Architecture, and ysics Departments.

The Micro-wave Gas Discharge Laboratory is studying the effects of micro-waves on gases. The three-meter resonant cavity above is the apparatus used in this study.

ne of the largest helium liquefiers in the orld in the Low Temperature Laboratory.



The control mechanism above is one of the major projects of the Dynamic Analysis and Control Laboratory.

BUILDING 20—

tech engineering news

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from the editor's notebook

The Usefulness of M. I. T....

If you are coming to M. I. T. for an education, and not merely a degree, consider the purpose of your school in your education. The Institute provides an instructor who can answer questions and clear up misunderstandings. The fact that many students seldom participate in class discussions and seldom see their instructors for help unfortunately indicates a widespread negative attitude toward getting something out of M. I. T.

Consider now the reasons for this neglect of offered aid. First to blame are the "brownies," the students who take up more than their share of the instructors' time, often not for the purpose of comprehension, but in order to get "in" with the instructor. These men use up the class time with their irrelevant questions and remarks, and waste the instructors' time with unnecessarily frequent visits. This abuse of the offered aid of the instructors has created an unwholesome atmosphere about student faculty relations which deters many students from asking for help from the faculty, for fear that they will be making themselves as obnoxious as the "brownies." Furthermore, a single "brownie" often uses almost all of the class time which can be allotted to discussion.

Second to blame are the students who let the unwholesome atmosphere discourage them from asking for help, or don't know enough about the subject to know what to ask. When the "brownie" of the class is the only one asking for the instructor's time what can he do but give it to him?

It is true that some students need more help than others, but right now the students who need help the least are getting the most. The usefulness of M. I. T. to the student can be greatly increased with a more equitable distribution among the students of help from the faculty.

M. M. B.

About the Authors...

You've probably noticed that one of this month's authors, Mr. O. A. Battista, is not a Tech man. "Rayon" is the commendable result of an experiment in having an industry write about itself. "Central Says" is the work of one of our new authors, prolific Eugene Mirabelli, Jr. Eugene is also the author of "Numbers," which appeared in the March issue. The thought provoking article on "Chess and Mathematics" is the first contribution of Harry F. Davis, a second year graduate student in Course XVIII. Bill Gorham, our helpful photographer, went on a tour of Tech's labs last month and produced the picture story for this month. Many of the illustrations for articles this year are also Bill's work.

power packages

(*Continued from page 7*)

is no problem of back-firing or hard starting; instead, glow-plugged engines start easier and are less critical than if they were spark plugged. The key to the prevention of premature ignition lies in the fact that the glow plug alone will not fire the fuel, but the rise in temperature due to compression enables the plug to finish the job at the right moment.

Inasmuch as glow plugs may be used in most ordinary spark plug engines, a great saving in weight, bulk, and complexity is afforded by their use. Furthermore, spark plugs have a limit to smallness, while glow plugs may be made (and have been by Ray Arden) as small as one-quarter inch high. Because of this, the miniature engine trade recently took a new lease on life by manufacturing engines one-fifth as small as ever before, thus permitting their use indoors and on small fields (in model airplanes) or ponds (in model boats). The smallest commercial engine in the United States as shown in figure 3 delivers about one-fortieth horsepower at 15,000 r.p.m. and weighs one ounce. Nearly half of the cylinder head is taken up by the glow element, but

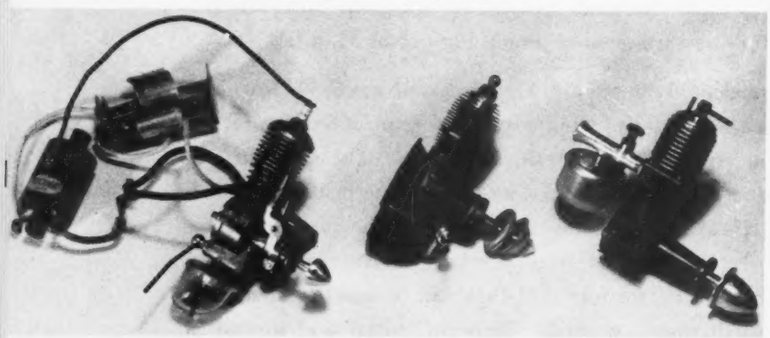

Figure 4

The three types of ignition systems in model engines are illustrated on the: "Atom" — spark ignition, "Arden .099" — Glow Plug, and the "Mills .078" — compression ignition.

this could be smaller at greater expense. Again, the one disadvantage is the single optimum engine speed.

So far, we know how the fuel-air charge is admitted to the engine and how it is ignited, but now let's discuss the fuel itself. One basic condition is imperative for all two-cycle engines: the fuel must have lubricating oil mixed with it as there is no oil sump in the crankcase. For spark ignition, regular fuel consists of about three parts unleaded gasoline to one part S.A.E. seventy oil which is viscous at ordinary temperatures but just right at high engine temperatures. In higher performance spark ignition engines, alcohol-castor oil fuel is used in nearly the same proportions as the regular fuel, with additives of amyl acetate or ether used to further the cooling effect. Alcohol fuel is used for two main reasons: it burns at a lower temperature, making it easier to dissipate cylinder wall heat, and the high evaporation rate cools the fuel-air mixture in the intake tube making it denser so that a greater mass of fuel-air per charge results. Castor oil is used as lubricant as it is the finest high-speed lubricant available.

Nearly all glow plug fuels use alcohol-castor oil base, but they also contain nitro-methane to give them a lower ignition temperature. The proportions vary somewhat but are on the order of thirty per cent nitromethane, forty per cent alcohol, and thirty per cent castor oil with numerous anti-toxic and engine preserving extras thrown in for the commercial fuels. Occasionally nitro-propane is added to gasoline-base fuels to permit their use in glow-plugged engines. In the "good old days" one would talk a gas station out of a gallon of gasoline, buy some good oil, and mix up fuel for a year. Nowadays he buys a can of the "Liquid Dynamite" at a store for three times the price complete with thirty ingredients added.

Diesel fuel is something else again. Extreme volatility is required yet good power is also important, so ether is the main constituent with castor oil usually used as lubricant. In Europe many weird formulae have been used, including such items as paraffin oil, kerosene, gasoline, turpentine, and even crude oil. American diesel fuels contain about three parts diethyl ether to one part castor oil, there often being a small amount of some catalyst added to improve combustion.

The alcohol base fuels are devastating to ordinary finishes, so that special "fuel proof" glue and covering are essential. Diesel fuel is slightly less harmful to ordinary finishes while gasoline fuels do not affect them at all.

Fifteen years ago an engine of .60 cubic inch displacement (cylinder volume swept out by piston from bottom to top of stroke) would give a shaky one-fifth horsepower at 4,000 r.p.m. Today the top racing engines of the same displacement put out one and one-half horsepower at 18,000 r.p.m.! Thus power has been increased more than seven-fold while engine speed has gone up four and one-half times as much. Power with high engine speed is the criterion for model plane racing, so special engines were developed to take the constant punishment characteristic of such use.

Racing engines are distinguishable from regular engines by their more rugged construction and fine finish inside. For instance, the Dooling 61, illustrated in figure 4, a top racing engine in its class, has two ball bearings on the crankshaft, another on its disk rotary valve, and a set of needle bearings on the lower end of its connecting rod. Piston rings are used on all racing engines, because the usual lapped pistons would expand and jam or "freeze" at the continued high temperature. The smallest piston ring in the world for internal combustion engines is a one-half inch one for a .099 cubic inch displacement engine. Still another characteristic of modern engines is that the bore (cylinder diameter) is greater than the stroke (crank diameter). It seems that the higher the speeds the engine is designed for, the greater the bore:stroke ratio. For example, on the Dooling 29 in figure 1 this ratio is 1.33:1!

Horsepower ratings vary from one-fortieth horsepower for the "Infant" engine to one and one-half horsepower for the Dooling 61. It is a safe assumption to say that for the smaller size engines (less than .10 cubic inches displacement) maximum horsepower approximately equals the displacement. This is also true for regular engines right on up the scale. For racing engines the horsepower equals about twice the displacement. Two horsepower per cubic inch may not seem a radical value to aircraft engine experts, but for such small mechanisms it is a remarkable achievement. The one horsepower per cubic inch rule should be reduced somewhat for most spark ignition engines, but it is true for glow plug and diesel types. One feature of the diesels which makes them desirable for free-flight model airplanes is that their power is developed at somewhat lower r.p.m. than for other types, being a maximum at 8,000 to 11,000 r.p.m. This enables the use of a more efficient propeller for low forward speeds.

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PIPE with WINGS

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At every point of its travel from cold to hot positions, this piping must have the same amount of support or "lift" so that none of the stress will be transferred along through the piping system. That's an engineering problem for which there's only one practical solution . . . what amounts to "wings for pipe". It's a constant-support pipe hanger, made only by Grinnell, which provides supporting force equal to the weight of the shifting pipe in all positions.

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chess and mathematics

(*Continued from page 8*)

more advanced techniques for solving problems, then we analyze these techniques and seek to reduce the restrictions under which they will work. Of course, we soon reach a point where we do not find an answer to our questions, and so we may arrive at a fifth, *research* stage, in which we seek new ideas and more powerful methods, or improvements of old ideas and methods.

Certainly these levels of generalization as so defined are highly arbitrary; they are given here for the purposes of comparison, as will be seen in the discussion of chess which follows. It must also be emphasized that these are levels defined from an engineering point of view; the mathematician would certainly want to point out that in all phases of mathematics, problems arise concerning the mathematics itself. These problems have nothing to do with the immediate physical problems that some engineers and physicists would see mathematicians work on exclusively. It is not uncommon for some mathematicians to devote all their time to working on these topics. So it is that mathematicians find difficulty explaining, even to educated laymen, what their research involves. How can they, when so much mathematical research is research on mathematics itself, at a higher level than the mathematical knowledge possessed by the questioner?

This alone is a primary cause of misunderstanding, but there is another that is much deeper. Unfortunately, but understandably, most people form their ideas concerning mathematics on the same level of generalization as that of the last mathematics they studied in school. Often the person who has not progressed beyond elementary arithmetic will ridicule the mathematician in this light: "He claims that an angle cannot be trisected simply because he has never succeeded in trisecting an angle." It is hopeless to explain to such a person that it is possible to prove something impossible, since he has no knowledge of elementary geometry and has therefore no idea of the meaning of "proof." On a higher level we hear the same kind of ridicule. Often engineers will question the value of current research in some branches of theoretical mathematics, where the studies seem to be nothing more than games played with elaborate sets of postulates and rules, having few or no immediate results. Needless to say, the mathematical knowledge possessed by these engineers is rarely beyond the advanced calculus level.

Chess

The first step in learning chess is that of learning the rules for moving pieces about the chessboard. It is interesting to note that this precedes learning the object of the game, just as learning the rules of computation (the algorithms) of arithmetic preceded learning the use of these rules (the word problems). For most people, the very object of chess is quite abstract; the beginning chess player does not know what checkmate means until he has "played" several games. The best way to teach chess is therefore the same as the best way to teach mathematics. The teacher must overlook for the moment the more general aspects and teach the "algorithms." So we learn (and marvel at) the move of the knight, we see how pieces are captured, and become acquainted with the various other details of the game, with the emphasis on the moves and not on the object of the game.

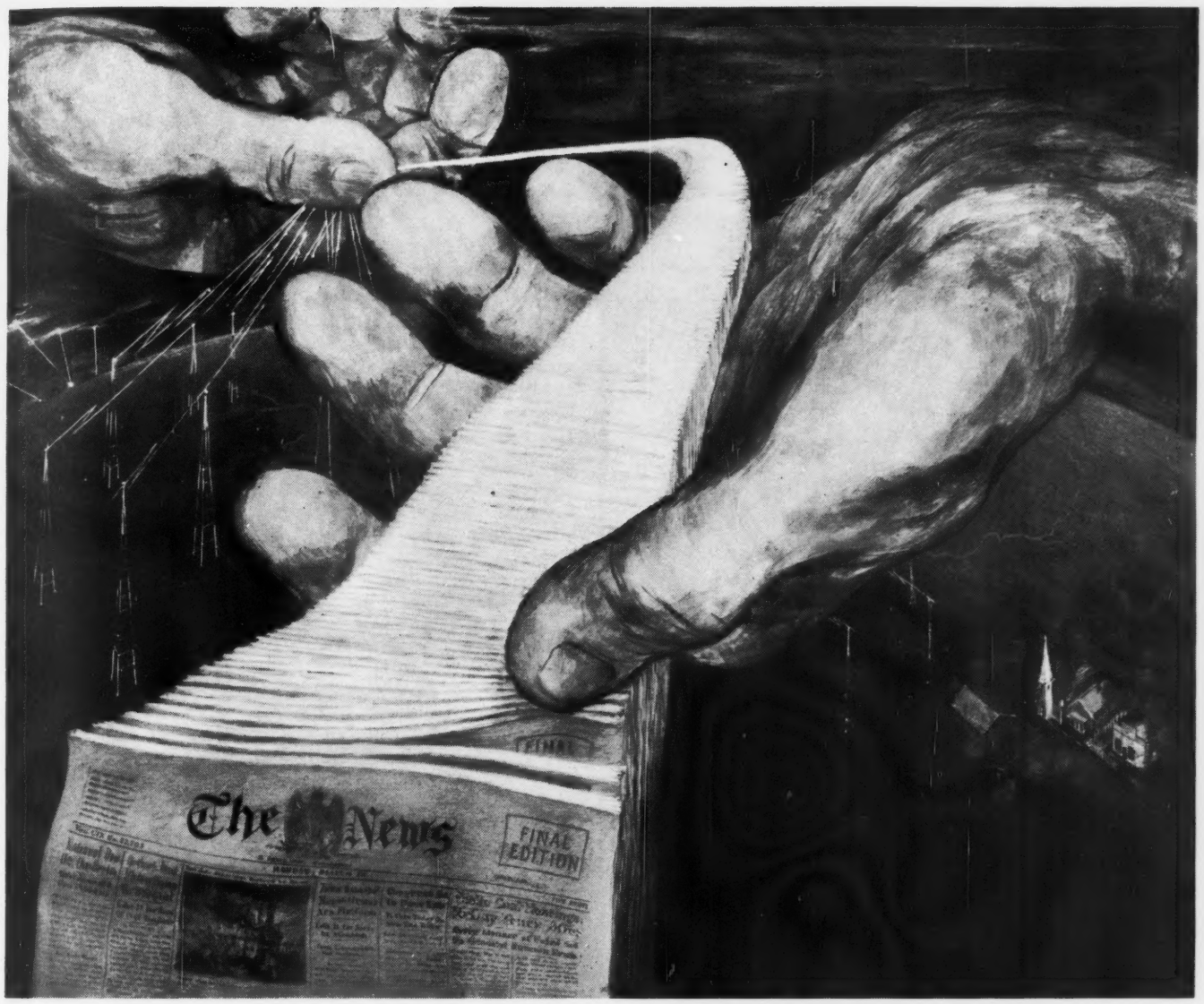
Of course, the rules are learned quickly by an intelligent person, for the novelty of the game is appealing to the imagination. A parallel exists in mathematics: What beginning calculus student has not been intrigued, and perhaps somewhat frightened, by the peculiar symbols he sees further on in the book?

The next step in learning chess, the "second stage of generalization" (in analogy with the discussion of math) is to learn the meaning of checkmate and the way a game of chess is conducted from beginning to end. Here definite rules cannot be given, and an element of ingenuity enters into the picture.

As in the learning of mathematics, by experience the student acquires a "bag of tricks," and it is at this level that most players remain. Tactics are the primary object of such players: Having once seen the trick in which a knight attacks two opposing pieces at once (called a "fork"), such a player usually tries to get his opponent into this trouble.

The third stage in development consists in learning the means whereby the ingenuity involved in the second stage may be overcome by fairly mechanical means. This is called *strategy*. Any modern textbook on chess gives a list of the general rules of strategy, such as developing the players early, not playing the queen too soon, the power of a rook on an open file, etc. The player begins to think in terms of a sequence of moves, called a "combination," instead of just a single move. He no longer hopes that his opponent will not notice his method of attack, for he must presume his opponent (if equally skilled) is not vulnerable to permitting a "fork," or at least that he can see the danger in advance. The difference between chess play at this third stage, and play in the second stage, is similar to the difference between modern warfare and medieval warfare. How-

(*Continued on page 24*)



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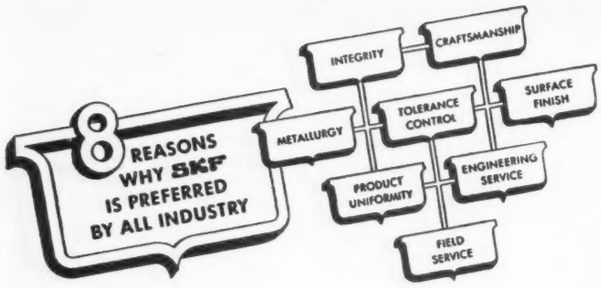

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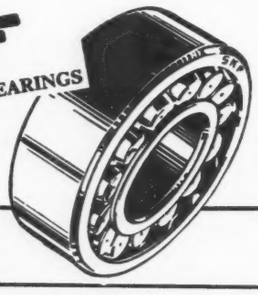

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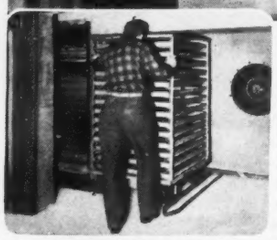

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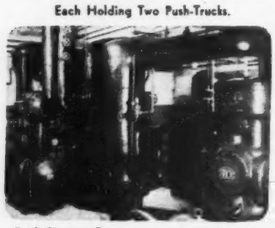

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chess and mathematics

(*Continued from page 22*)

ever, there are even higher levels of play, although the player in an average chess club has hardly progressed further.

In the fourth stage, the chess player (who is probably considered an expert by now) pauses to examine more carefully "why" the rules of strategy work so well. This involves a more thorough analysis of the basic ideas, just as much advanced mathematics is concerned with the proper definition of the elementary concept of number. The principles of end-game play, the openings, the analysis of a chess "situation" in the middle game, all become quite important. The player at this stage is more cautious in his attacking play, and becomes more interested in "positional" play, in which the opposing sides jockey back and forth to obtain subtle positional advantages that a less experienced player would not understand at all. A large part of learning "higher chess" consists of a repetition of these two stages. One analyzes further the various classified chess openings and the enormous number of published championship games, and thus learns more advanced techniques. Then one pauses to examine these techniques and see how far the generalization can go.

Needless to say, there is a research stage here, just as there is in mathematics. This research can become just as impractical from a chess player's point of view as mathematics research can become from an engineer's point of view. Books have been written on chess problems, for example, and many newspapers publish these synthetic situations ("White to move and mate in three moves. . . . "). Many chess players devote most of their leisure time to working on chess problems. Yet these appear to many tournament players to be very useless, inasmuch as the occurrence of such artificial situations as occur in many problems is utterly inconceivable in the actual playing of chess.

The reason most chess players are misunderstood by those who do not play chess is that most people form their judgment of chess on the same level of generalization as that of the game most nearly like chess that they have played, i.e. checkers. The person who has not played chess, but who has played checkers, somehow believes that there is a similarity between the games. This is understandable because checkers is also played on a chessboard. To say to such a person that chess is a wholly different thing, to tell him that those who spend twenty minutes on each chess move are actually in a highly strained mood of excitement, to describe to him the awful tension that can exist among the spectators of a championship chess game at a crucial moment in the play, is to invite ridicule. He cannot imagine it because he has not played a game remotely like chess. To answer his challenge that chess is an old man's game is as senseless as to answer the challenge mentioned previously about trisecting an angle. However, if there is a chess club nearby, one can demonstrate the truth of the negative!

Of particular importance to the student is the following: Those who excel in chess and mathematics are not those with the largest bag of tricks, but those who have the deepest insight into the basic ideas involved. The freshman, who feels pained at derivations, and thumbs his textbook until he finds a likely formula to solve his problem, might do well to consider this point. What appears to be brilliance and orig-

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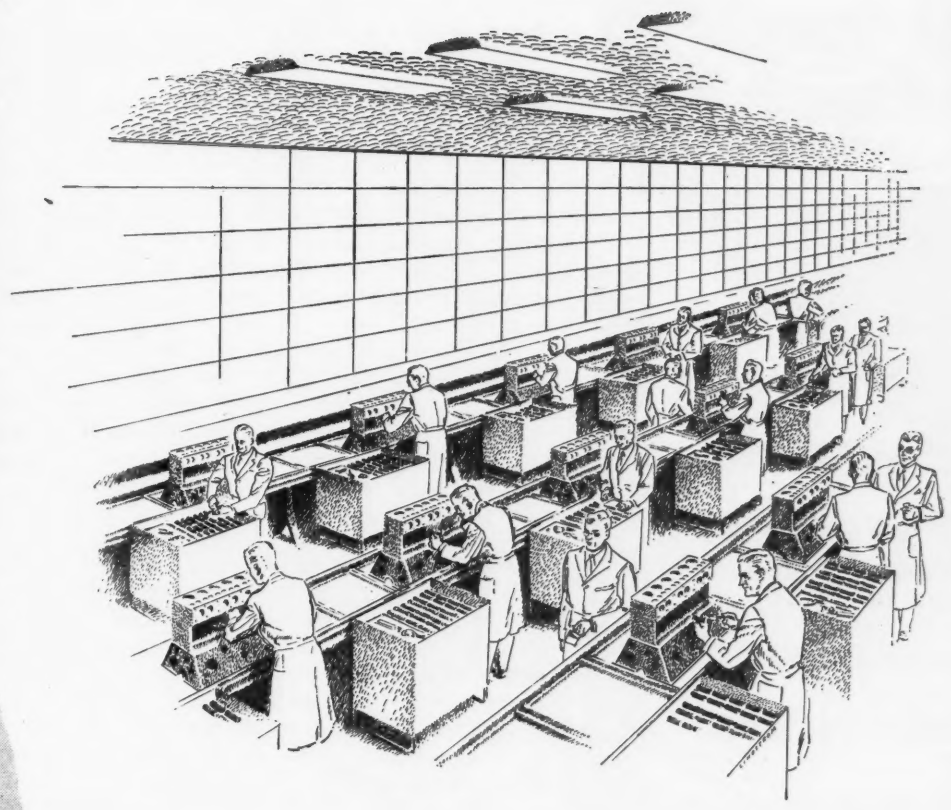

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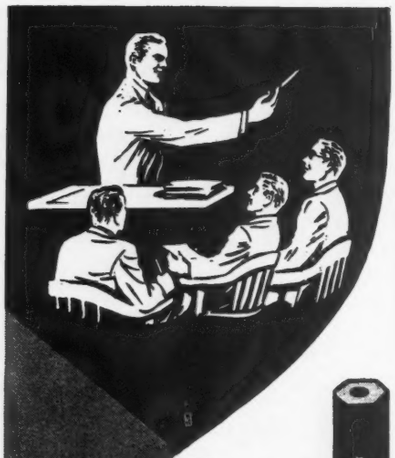

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chess and mathematics

(*Continued from page 24*)

inality, in both chess and in mathematics, is often little more than a thorough knowledge of fundamental principles.

It might appear from this discussion that all one need do to become a chess master is to thoroughly study the literature, learn these fundamentals thoroughly, and then go forth confidently, ready to defeat any and all comers. However, the state of the theory of chess is not so far advanced that this can be done. The strategical rules of chess are heuristic and incomplete. The complete analysis of a chess position is an exceedingly complicated thing, to be attempted only by those who have acquired great experience in actual play. It is this incompleteness in the theory of chess that is a stumbling block to the theoretician. It is at this point that chess and mathematics, which we see are in many respects parallel, begin to merge.

On the one hand, there is a vast amount of written material on chess, including both strategical rules and actual records of tournament games. The person who understands chess notation can run through the recorded championship games and gain considerable insight into the methods of the experts by actually studying the games they play. These games are therefore a wealth of material for the person who would desire to do chess research.

On the other hand, there is also in existence a wealth of mathematics which might apply to chess. The simple theory of maxima and minima, i.e. the problem every freshman solves of finding the maximum of a function by setting its first derivative equal to zero, suggests the possibility that a formula might be given for "chess potential." The calculation of the move that would increase a player's potential the most would then be a problem in elementary calculus. I use this example because the idea is probably familiar to most of my readers; of course, the solution is not so trivial.

To a certain extent every chess player uses mathematics in his chess; most players rate the value of each piece as a function of both time and position. For example, a knight is considered worth about the same as three pawns; its value is greater when it is near the center of the board than when it is near one edge, and it is of less value in the end-game than early in the game. If really sure-fire methods could be constructed to determine the best possible move in any given chess position, the construction of a machine that would play chess becomes a straightforward process. At present, all that can be done is to bring a mathematical machine as far up the ladder of generalization as the patience of the builder permits. It is safe to say that such attempts will be made only on about the second level, i.e. the machine can be taught to make valid moves, moves that do not lead to disaster against short-chain combinations, and that are aimed at the general idea of producing a checkmate. Such a machine will not fare well against a human opponent who knows longer combinations than are built into the "memory" of the machine, and could not compete with positional play at all. The device would be an expensive one for the instruction of beginners, but quite uninteresting to even an average chess club player.

More intriguing by far than the application of mathematics to chess is the possibility of applying chess to mathematics. If a mathematical means were developed whereby chess problems could be solved easily, that in itself would represent an advance in mathematics. In principle, chess is a game which can be solved completely by mathematics; the difficulty is that *no one has the time to do it.* This is just the difficulty that is becoming of increasing importance in mathematics, and is the basic motivation behind the gigantic "brains" that are being constructed in so many institutions. If there were developed a way whereby the enormous number of chess games could be fed into these machines (move for move, in some suitable code) with the "brain" sorting out, on some probability basis, those features which are most in common to the moves of winning players, some information might thus be obtained which is of greater value than the existing strategical rules. In a sense, the records of chess games are the "data" of chess, and from this mass of experience may come more valuable information than previously thought possible.

An approach hardly mentioned, is that of reducing chess to some mathematical equivalent that is susceptible to direct analytical attack. This would use nothing more basic than the given rules of the game, and

(*Continued on page 38*)

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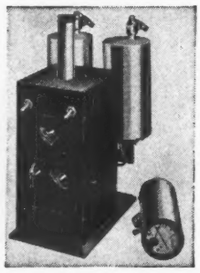

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Lindemann-Ryerson Electrometer has high sensitivity and good stability. Does not require leveling. When reading, the upper end of the needle is observed on a scale illuminated through a window in bottom of case. Size 8.3 X 6.5 X 3.5 cm.

Pocket Gamma Ray Dosimeter is a personnel monitoring instrument to measure cumulative exposure to gamma or x-rays over a given period. Contains an ionization chamber, a quartz fibre electrometer and viewing system.

Precision Ionization Meter (Failla Design) a complete instrument for null methods of radioactivity measurement where background radiation effects must be eliminated.

Send for complete information

CAMBRIDGE INSTRUMENT CO., INC.
3756 Grand Central Terminal, New York 17, N. Y.
PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

rayons... custom built fibers

(*Continued from page 12*)

Having transformed the cellulose into solid cellulose acetate as required, the flakes are dissolved in acetone to form the spinning solution. Whereas the concentration of cellulose in the viscose spinning solution normally ranges from 7 to 9 per cent, concentrations of cellulose acetate in the acetate spinning dope run as high as 25 per cent or better. Forced through stainless steel spinnerets, the acetone solution of cellulose acetate is directed down a tube or shaft containing warm, humid air. The acetone evaporates quickly, and is recovered, while the continuous filaments of acetate rayon are collected on high-speed bobbins.

If rayon could speak its piece today, it probably would say, "You can't keep a good product down." It has had to earn its current reputation and widespread acceptance in the textile trade.

Viscose rayon and acetate rayon are blood relatives, each having its own characteristics. And herein lies rayon's greatest selling points. Unlike the natural fibers, man-made rayon may be cut to any desired length. As a staple fiber it is used usually from about one to six inches in length, although many new uses are being found for very short length fibers. As a continuous filament, American Viscose Corporation has succeeded in doing something that would certainly gladden the heart of Chardonnet if he were alive today. They have produced a rayon thread that is so fine that a single pound of it would stretch non-stop from New York to San Francisco.

Other factors, too, speak for America's billion dollar rayon industry. A filament is a single fiber, and a number of filaments are combined to form a strand of yarn. In addition to being able to make rayon filaments finer than those of the silkworm or thicker than coarse wool, rayon yarns may contain any number of filaments. Usually the range is from 13 to 270. The degree of luster of rayons may be controlled, as well as their strength, whiteness, and their affinity for a wide variety of dyestuffs.

Rayon can be and constantly is being improved or modified to meet special needs as they arise. Rayon tire cord, for example, is one illustration of such a modification. Within the past decade, hundreds of millions of pounds of a tough, high-strength rayon tailored for the job have gone into the manufacture of reinforcing fabric for rubber tires used on airplanes, trucks and passenger cars. Rayon tire cord imparts exceptional strength to a rubber tire, as well as resistance to heat and flexing when it is under a heavy load.

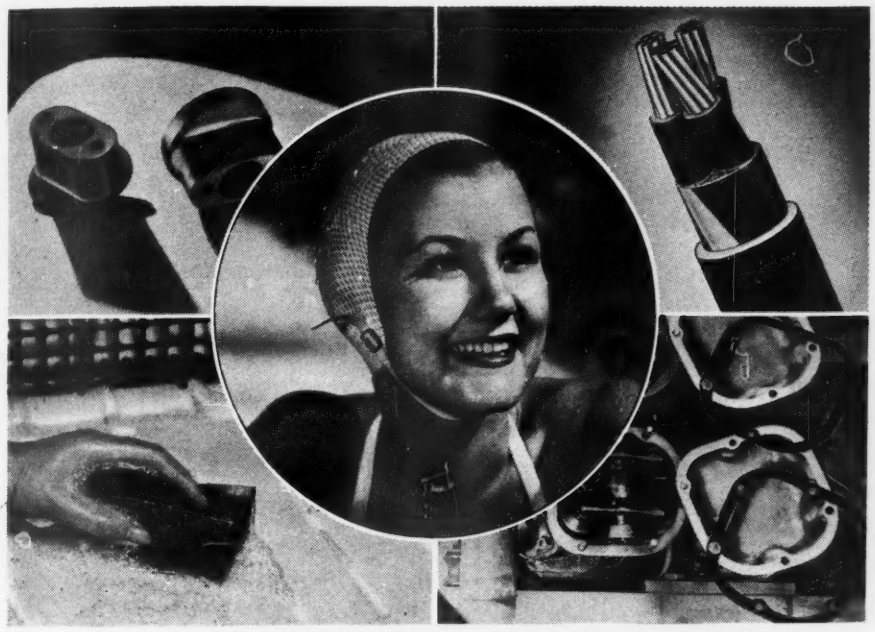
No lone wolf, rayon performs its services to man in combination with one or more of the natural fibers. In this way, fabrics having unique qualities, qualities that may not be obtained in any other way, are being produced.

Verily, the successors of Robert Hooke have had no occasion to be displeased as they duplicated and improved upon the silkworm's art.

THE DU PONT DIGEST

With the development of Neoprene Type W

Science Again Outpoints Nature



Motor mountings, wire and cable, sponge, gaskets, swim caps are among possible uses for Du Pont's new Neoprene Type W.

NEOPRENE — the chloroprene rubber produced by Du Pont research—has long outpointed natural rubber on many counts. Because of its greater resistance to chemicals, flame, heat, sunlight, weathering, oxidation, oils, grease and abrasion, it is widely used in such products as industrial hose, conveyor and transmission belts, insulated wire and cable, hospital sheeting, gloves and automotive parts.

Until recently, however, certain natural rubber compositions couldn't be beaten when it came to "permanent set" characteristics. Released from the pressure of prolonged deformation, they returned more nearly to their original shape.

This recovery factor is important to some manufacturers, particularly the people who make gaskets, seals, diaphragms, sheet packing, soft rolls and vibration-dampening devices.

NEW PRODUCT NEEDED

Much as they wanted to use neoprene because of its other superiorities, they often needed more resistance to permanent deformation than it afforded. So they used natural rubber, but were never quite satisfied with the way it resisted deterioration in severe service.

Du Pont scientists went to work to solve the problem. Skilled research chemists, physicists, engineers and others pooled their efforts. The result was a new polymer named Neoprene Type W.

NEOPRENE TYPE W INTRODUCED

Chemically, the new neoprene is quite similar to previous types. But its molecular structure has been changed so that the mechanical properties of its compositions are more nearly like those of rubber. With Neoprene Type W, it is possible to produce vibration-dampening devices that are not only highly resistant to oils, heat, grease and sunlight, but recover better than rubber from prolonged pressure.

Jackson Laboratory, Deepwater, N. J., one of Du Pont's laboratories which participated in the development of Neoprene Type W.

Neoprene Type W also provides the basis for compositions that have a low modulus of elasticity—are easy to stretch. More attractive colors are possible. Soon it may appear in such articles as swim caps, where bright colors and head comfort are important. The brighter-colored compositions should also appeal to makers of appliance cords, coasters, sink mats, stove mats and toys.

In developing the uses of Neoprene Type W, Du Pont is working with hundreds of manufacturers and distributors. Once again a "partnership" of big and small businesses will cooperate to give Americans the benefits of an advance in science.

★ ★ ★

SEND FOR "The Story of Coal, Air and Water," a 28-page illustrated booklet describing the chemical ingenuity behind the development of neoprene, nylon, and other products. For your free copy, write to the Du Pont Company, 2503 Nemours Bldg., Wilmington, Delaware.

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FOR YOU?

SYNTHANE a plastic laminate may be just the material you've been seeking. It may give you some good ideas on how to make your product or process better . . . and less expensive.

Synthane is light as a mouse. But that's not all—for it has a *combination* of valuable mechanical, electrical and chemical properties useful in many applications, in almost every industry. Electrically, Synthane combines high dielectric strength with low power factor and low moisture absorption. Mechanically, it is hard, dense, highly resistant to impact fatigue, abrasion and wear. Chemically, it stoutly resists corrosive liquids and atmospheres. Yet with all this, Synthane is easily machined on standard equipment. Synthane rods and tubes are excellent for high-speed production on automatic screw machines.

These and many other properties—*combined*—make Synthane adaptable to countless chemical, electrical and mechanical applications, Synthane Corporation, 24 River Road, Oakes, Pa.

Plastics where plastics belong

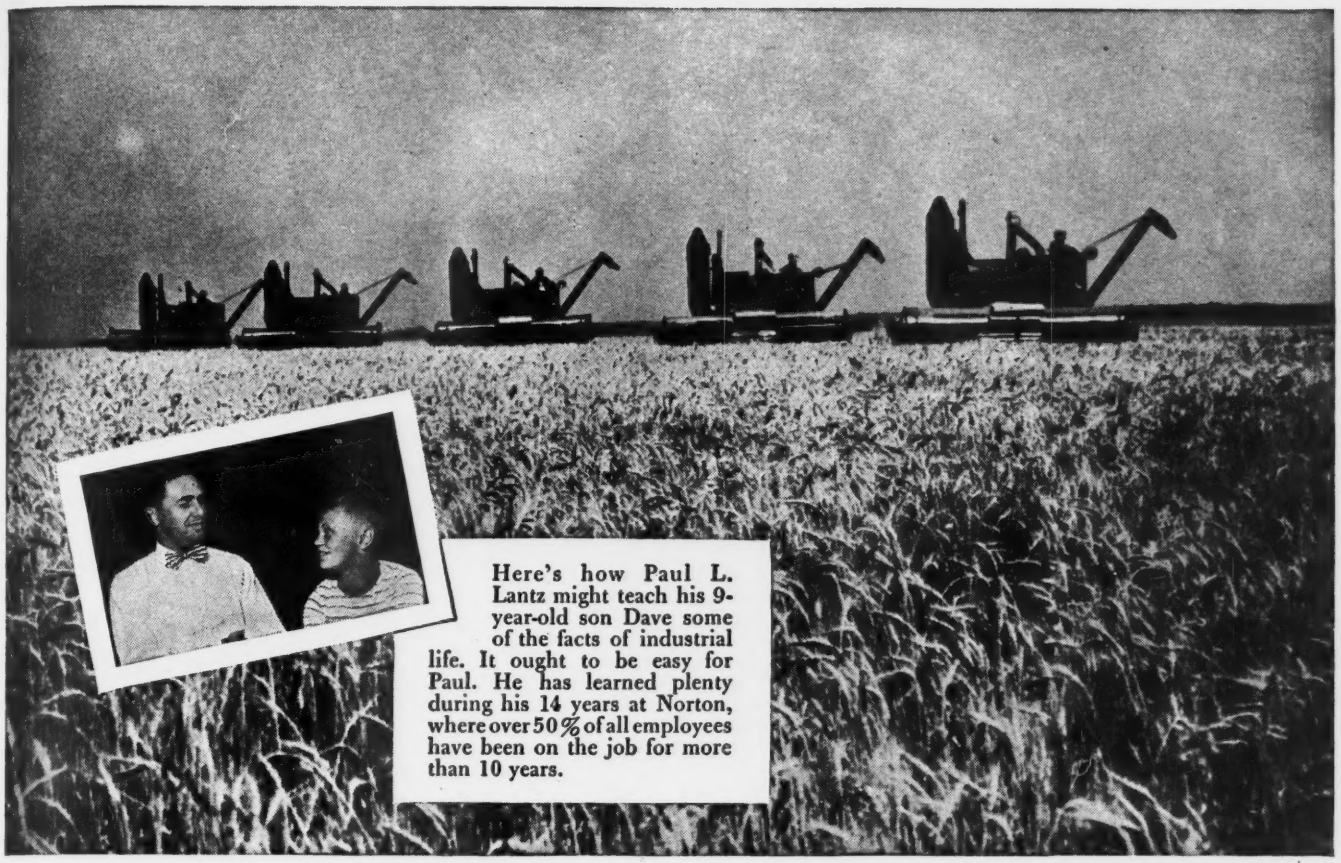
SYNTHANE

where Synthane belongs

SYNTHANE AT WORK IN INDUSTRY

Cleveland Pneumatic Tool Company, makers of Aerol Landing Gear Shock Strut for the U.S. Air Force Bomber, B-36, selected Synthane as the right material for the bearing shown because of light weight, wear resistance, low friction quality, good compressive strength, excellent shock resistance, and the close tolerances to which it may be fabricated. Are these qualities valuable to you?

DESIGN • MATERIALS • FABRICATION • SHEETS • RODS • TUBES • MOLDED-MACERATED • MOLDED-LAMINATED



Here's how Paul L. Lantz might teach his 9-year-old son Dave some of the facts of industrial life. It ought to be easy for Paul. He has learned plenty during his 14 years at Norton, where over 50% of all employees have been on the job for more than 10 years.

A quintet of combines in action.

"Is Farming as easy as it looks, Dad?"

"No, son. It's just easier than it used to be, thanks to the farm equipment manufacturers who are always finding new and better ways to make farming more efficient."

"Diesel tractors give more power than 100 horses. Smooth, rugged power derived from accurate, close-fitting parts. Norton Lapping Machines finish these parts to closest tolerances possible in mass production.

"Parts like cultivator discs and plow-shares, made of today's tougher metals, stand rougher treatment. Fast-cutting Alundum grinding wheels, or Alundum-coated polishing wheels, finish these parts *right!*

"Grinding and finishing implement parts, sharpening cutting tools, heat-treating metals for improved properties are among the vital farm-equipment jobs entrusted to Norton grinding wheels, machines and refractories."

"Yes, indeed, Dave, the Norton products I help make are an important part of the preparation of every meal you eat. As a matter of fact, just about everything that makes living worthwhile today is a little bit better because Norton products added something extra to it."

NORTON

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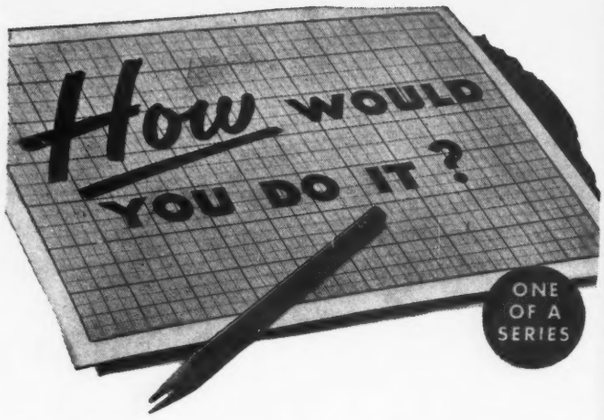
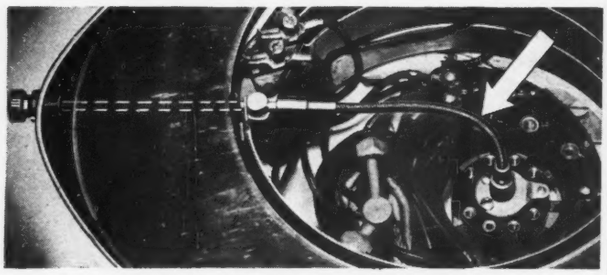


PROBLEM — You are designing a machine which includes a number of electrical accessories any one of which can be turned on by means of a rotary switch. For reasons of assembly and wiring this switch has to be centrally located inside the machine. Your problem is to provide a means of operating the switch from a convenient outside point. How would you do it?

THE SIMPLE ANSWER — Use an S.S.White remote control type flexible shaft to connect the switch to its control knob. This arrangement gives you complete freedom in placing both the switch and the control knob anywhere you want them. That's the way one manufacturer does it in the view below of part of the equipment with cover removed.



This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. That's why every engineer should be familiar with these "Metal Muscles"* for mechanical bodies.

*Trademark Reg. U. S. Pat. Off. and elsewhere

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for asking. Write today.

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QUICK QUIZ ON INSULATED CABLES

Q. What kind of cable testing comes closest to duplicating actual service conditions?

A. Proving ground tests. Since 1936, Okonite engineers have been studying cables in an outdoor proving ground. Cables are buried in various soils, pulled in conduit, strung overhead, subjected to temperature, voltage and loading conditions that duplicate actual operation. Facts gained here are recorded, evaluated, and added to Okonite's 72 years of experience in making the highest quality insulated cables.

THE OKONITE COMPANY, PASSAIC, NEW JERSEY

THE BEST CABLE IS YOUR BEST POLICY

OKONITE insulated wires and cables

8031

central says:

(*Continued from page 13*)

Sherwood smiled. "Whatever form of emotional insanity it is, is immaterial. The fact is that the machine has developed a warped personality. This isn't caused by some tubes blowing out. We can't fix it by replacing a few burned-out fuses; nothing so simple. The easiest thing to do is to disassemble the machine and sell it for junk."

"But . . ."

"The machine is insane; it has no use; it must be destroyed."

"Yes, of course."

Sherwood gathered his papers together and left the two of them alone in the room. They stood silent for a moment.

"I guess that's that," he said.

"Now what?"

"How about something to eat? I'm starved." They stepped out into the slush of melting snow. And as they walked, he spoke. "You know, I've been thinking — "

"Don't strain yourself; that's what machines are for."

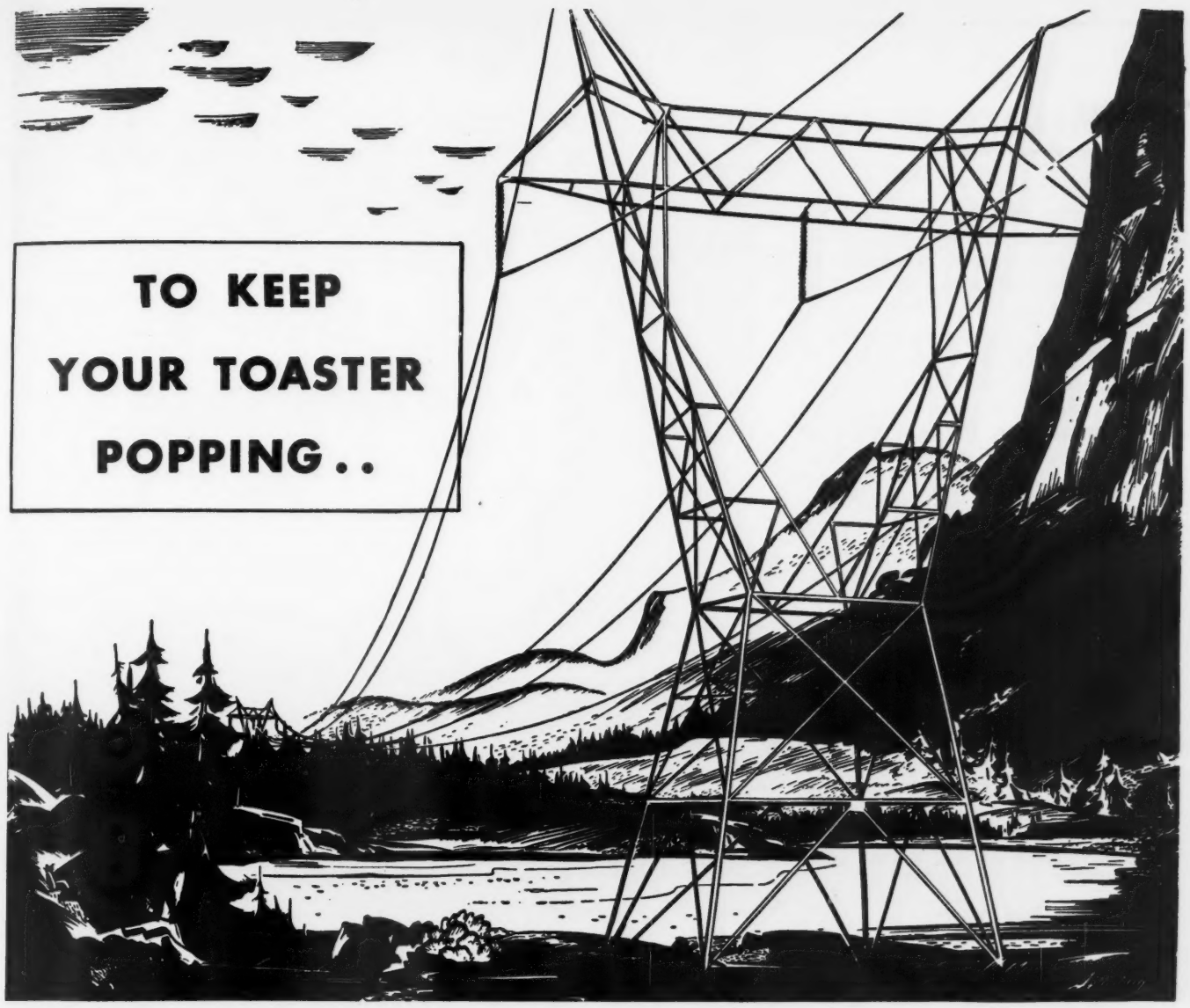
"I'm serious. I've decided, as long as this break has come along the way it has, that I'm going to ask for a transfer."

"Transfer? To what?"

"History research."

Three months later they walked down the same lawn. Spring was best of all, thought John. He looked at the girl walking beside him. No trace of anxiety on her face; she was so damn serene. They walked for

(*Continued on page 38*)



Six million electric ranges. 37 million radios. 29 million electric clocks. 27 million electric refrigerators. 17 million electric coffee makers. 23 million toasters... *Thirty years ago, they were just a sparkle in someone's eye.*

Facts like that should hearten you, when you wonder about your future in American industry. The opportunity's there—as it was there for Alcoa in the early days of electrical transmission.

Today, nearly half the high-tension lines that feed those appliances are made of Alcoa Aluminum. Nearly two million miles of ACSR (aluminum cable steel reinforced). Although it was light, and corrosion resistant, and conductive, nobody wanted to make aluminum into cable, at the beginning. All right, we said—we'd do it. We launched a long research project to produce purer metal, and made the basic changes in our reduction processes that the research finally indicated. We built a cable-testing laboratory long enough to mount whole spans of cable, and vibrate them as the wind does, to check fatigue strength. This was hard, discouraging work, and it took most of the lifetimes of a good many Alcoa people.

But today aluminum high-lines cross the Great Bear in Canada, and funnel Grand Coulee's power into millions of homes and factories. We think they stand as a pretty good monument to this country's way of doing things, through research perseverance, stockholders' courage, and employees' hard work. ALUMINUM COMPANY OF AMERICA, 742D Gulf Building, Pittsburgh 19, Penna.

ALCOA FIRST IN ALUMINUM

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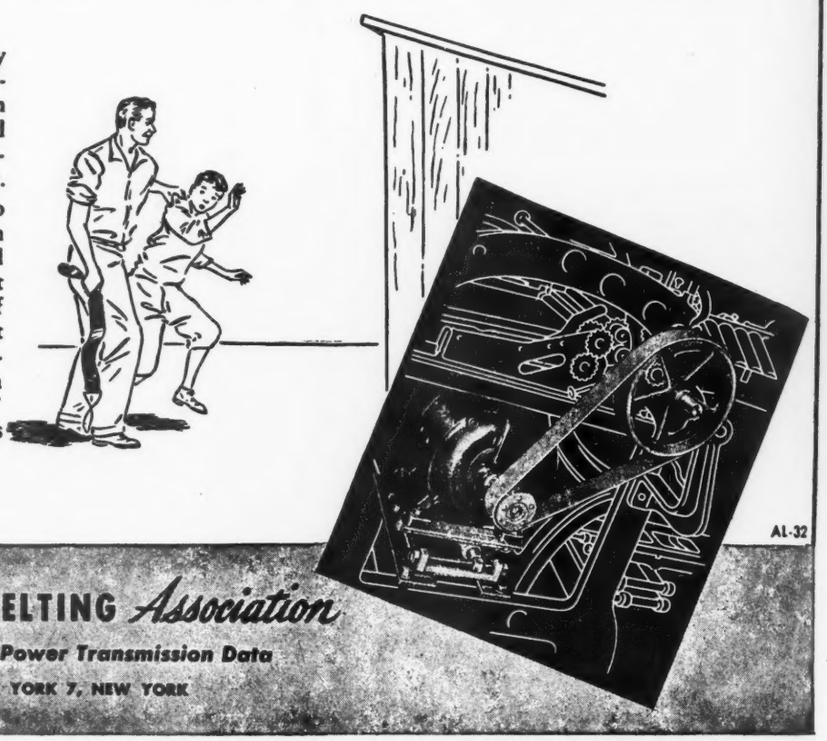
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

Modern power applications call for leather, too

There was something mighty impressive about those old-time woodshed sessions with Dad's leather razor strop. Dad had a very effective way of putting power to work via leather.

Here's the modern way to transmit power by leather in industry. The tension-control motor base puts the inherent power-carrying advantage of leather to work in compact space. The base plus the "single-pull" leather belt make a drive package that is "right" for many vital spots in today's industry.



AL-32

American LEATHER BELTING Association

Headquarters for Authentic Power Transmission Data

41 PARK ROW, NEW YORK 7, NEW YORK

workshop for peace

(*Continued from page 15*)

penetration also depends on the ratio of window height to room depth, since the nearer the window is to the ceiling, the greater is the penetration into the room. It was planned to bring the windows as high as possible. Window shape also controls the amount of light. A continuous band of windows results in a very even and diffused light source, as opposed to windows placed in solid walls which tend to become blinding spots against dark backgrounds. When the question of type of window came up, it was decided to use aluminum double-hung sash. These are inexpensive, easy to operate, and require very little maintenance. Solar heat presented a grave problem, particularly in the summer, but heat absorbing glass is planned to reduce this difficulty. This light blue-green tinted glass gives a unique opalescent quality to the buildings. Venetian blinds will control the direct sun.

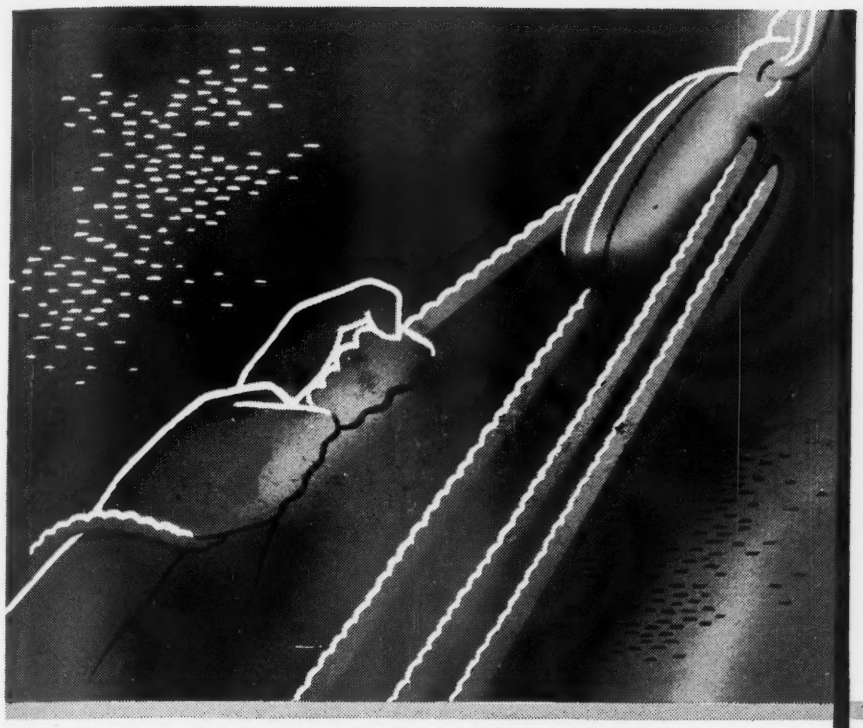
The treatment of windows is the most striking and controversial single element in this design. During the day, the east and west facades of the structures give the impression of one huge area of glass subdivided by many fine lines. There has been no attempt to hide the insides of the Secretariat building. This clearly matches the aspirations of the United Nations as an organization. For the sake of a continuous surface, colored glass has been placed over the spandrel beams between floors. Thus at night the building will appear quite different from the day. Then the fact that the windows are actually bands and that the space between floors is solid will become very apparent.

The assembly rooms which demand the most flexible regulation of lighting and mechanical ventilation remain windowless. Artificial lighting of the work and meeting areas has been designed with consideration for the color and reflection factors of desk tops, furniture, floor, walls and ceilings. Every item works toward needed visual unification.

Orientation, circulation, use function, flexibility, and lighting are all contributing factors to the design. Structure gives this planning reality. The building spaces are of two types — standard dimensioned offices and assembly rooms and halls of varying sizes. The first would fit into a standardized structural lay while the latter needed a larger structural framework. On the low buildings a wide spacing of columns at the lowest levels is necessary to provide adequate parking space below ground. The spans of some of the assembly rooms are ninety feet long, and require very deep trusses. An intermediate floor was devised so that the top chord of the truss supports the floor above while the lower chord supports the intermediate floor level. The ceiling of the chamber is hung from the truss; thus the height of the truss itself forms another floor space. This deep truss construction is in fact very useful since the intermediate space will be used by the service personnel as well as for mechanical equipment, air conditioning ducts, and lighting access. The ceilings that are hung from the trusses can have the special lighting effect and the necessary acoustic treatment.

The slab-like shape of the Secretariat building presents a major difficulty. Because of its very high, thin form it is especially susceptible to wind pressure. Lateral wind loads controlled sizes rather than vertical loads. A major criticism of the building is its extreme

(*Continued on page 36*)



When sail trimming is required

No business can stay healthy without an occasional overhaul of its production set-up—particularly when a seller's market begins to quiver.

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Have you heard what they're saying about NE?

Some grad is spreading the word that National Electric is the world's largest single source of supply for electrical roughing-in materials. (And he couldn't be righter!)

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Engineers, on all types of jobs, show a big preference for the *Lufkin "Ranger"* with the exclusive *Chrome-Clad* finish that enables them to "See Right—Be Right" under any kind of light condition. It's the finish that won't chip, crack, peel, or corrode! Permanent, easy-to-read black markings stand out sharp against the chrome white background. The *"Ranger"* tape is ¼-in. wide, sturdy, flexible, with "Instantaneous Readings". . . is enclosed in a genuine leather case. Learn why the *Lufkin "Ranger"* is engineered to give *you* better measuring. See them at your nearest *Lufkin* dealer.

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workshop for peace

(*Continued from page 34*)

slenderness. Not only does this necessitate excessive wind bracing but it also fails to function properly in plan. The elevators are placed off-center to allow large offices on the river side of the building, which results in a twelve-foot deep office space on the west side. These shallow spaces are also used for service and utility areas. This compromise in favor of a preconceived form is unfortunate.

The need for speed of erection and the great height of the Secretariat demanded steel construction. As an honest and sensitive expression of this type of structure, the building is unique. There is no false emphasis on horizontal or vertical lines as is found in other New York office buildings. Again the expression of the building is in sympathy with the aspirations of the organization itself, in its search for honest expression.

Delegates from varying climatic environments demand different temperatures and humidity ranges, which are provided for by an unusually versatile system. A complete conditioning system with both heat absorbing and heat liberating controls allows for maximum individual control while maintaining the necessary economy. Variations in solar radiation not controlled by the special glass are adjusted by a separate air-conditioning system under the windows. For general air-conditioning, maximum velocity and minimum-sized ducts are used to save space. "Under the window" modifiers are water coil fed. Large assembly rooms have more available space in the intermediate level and can therefore use low speed, large sized ducts. This, in addition to considerations of view, light and acoustics, is an example of the careful analysis that has been made of the staff's needs. A working environment has been provided which will help the personnel to do their very important work well.

The planners recognized the fact that acoustics is not a corrective science but rather one to be applied in the design of the various rooms. Noise had to be reduced to acceptable levels but the most serious problem was that of arriving at the highest possible value of speech intelligibility in the meeting rooms. Every room was designed as close to its optimum shape as possible, so that corrective treatment could be held to a minimum. The larger assembly rooms, due to functional, structural, or aesthetic reasons, needed more applied treatment than the smaller meeting rooms, which could be properly shaped.

The intra-building communication system recognizes the importance of the general meetings or the special committee sessions since special methods are used to permit all delegates to know what is occurring. A system of intercommunicating telephones has been developed by which delegates can listen to the discussion in any one of a number of simultaneous translations. Television viewers may also help the members to see as well as hear what is occurring. Electric conveyors and pneumatic tubes will speed official records and mail. This, plus public address systems, indicates the care that has been taken to insure the swift circulation of news. Just as efficiently as the buildings are intraconnected so are they related to the outside world by telephone, telegraph, teletype, cable radio and television.

A project the size of the U.N. Headquarters could not have been undertaken without the unprecedented

(*Continued on page 38*)

He uses 7/8 of the earth's elements in his cooking

If you've always thought of glass simply as a substance made of sand, soda, and lime, we believe this will surprise you:

Corning scientists, such as the one you see here cooking up a batch of experimental glass, *have actually made glass using 84 of the earth's presently known 96 elements.*

Nearly 3000 of these experimental glass compositions are turned out every year, as Corning scientists search for new and useful ways to combine nature's elements.

Already Corning has developed more than 50,000 formulas for glass. Just as alloys make metals more useful, these 50,000 formulas make glass more useful—enlarging its applications in untold and sometimes surprising ways.

Corning makes glass so strong that it can be used as piping in a steel mill. Corning makes glass so soft that it can be melted with a match—and glass so resistant to thermal shock that it can be heated to a cherry red, then plunged into ice water without its breaking.

Today, throughout industry, *Corning means research in glass*—research which, along with a multitude of other developments, has made glass one of today's most versatile engineering materials.

Corning is constantly turning up new kinds of glass, new uses for existing ones. So when you're out of college, and concerned with product or process improvement, it will pay you to call on Corning before your planning reaches the blueprint stage. *Corning Glass Works, Corning, New York.*

CORNING
means research in glass

chess and mathematics

(*Continued from page 26*)

since it has its start in mathematics itself this can hardly be called an application of chess to mathematics. A simple computation in probability will convince the reader that simple methods of analysis would take many lifetimes!

If the recorded data of chess could yield some successful attack on chess, it is probable that chess, in so dying, would enrich mathematics considerably. This is akin to the idea of using computing machines to find numerical solutions of differential equations, and by studying the tables of data thus obtained finding out more about the theory of differential equations. It is safe to say that the time of these machines, which is very costly, will not be spent on chess until the latter type of problem has been well exhausted! Like mathematicians, chess masters do not become very wealthy, and government subsidy for chess awaits a new era of socialism!

Some time in the future, chess, in the form now played, will have a trivial status. Perhaps it will represent one chapter in the development of a powerful new mathematical method. Presumably by then chess players and mathematicians will be contemplating further horizons. Those many of us who study both chess and mathematics, finding both of these to be alive in the very real sense of that word, know that something comparable to chess and mathematics will always exist, to try the ingenuity of the thinking man and give him problems to consider.

workshop for peace

(*Continued from page 36*)

unification of four of the largest contractors in New York. Fuller, Turner, Walsh, and Slattery combined their forces to build the required structures.

At the first stage of design a forty-five story Secretariat building and more spacious assembly rooms were contemplated, but the excessive cost made a reduction to thirty-nine stories and smaller meeting halls a necessity. This has actually resulted in a better plan since areas were recalculated and more simple and effective use of the space has been made. The entire project is estimated to cost $65,000,000. This sum has been lent interest free to the U.N. by the United States.

It is hoped that on January of 1951 some 889,000 square feet (nearly twenty acres) will be ready for United Nation's occupancy. This is a daring building fulfilling requirements set by an equally daring idea of world cooperation. There has been a complete study of how man will work best and under what environment he will perform the huge task of world government well. Only time and the exacting test of day to day use can say whether these buildings will function as a true "workshop for peace."

central says:

(*Continued from page 32*)

a long while in silence. A random shaft of sunlight, piercing the foliage, struck down on them. He noticed the sun fall flashing on her hair and throat. "Why don't you let your hair grow longer?" he asked.

"What a silly question! For the same reason that you don't let yours. Who ever heard of such a thing? Central says that the — "

"Skip it."

"What's wrong now?"

"Nothing."

"Something is. Ever since you started on that history research you've been so . . . queer. You should get out and be more active."

"Yes, yes, you've said that before."

"Well, it's true."

"Forget it. Forget that I ever said anything."

"But how can I? And the other day, all those crazy questions you asked me about that love stuff. You know what Central says: lust is natural, but love is insanity. And Central — "

"All right! All right! I — damn."

They walked on in silence. Finally she spoke. "Are you happier now that you've transferred to history research?"

"Same as usual."

"What do you do all day? Just read?"

"Most of the time."

"What do you do the rest of the time?"

"Paint."

"Paint?"

"Yes."

"Pictures? Like the ancients?"

"Yes."

They walked on in silence. And at last they parted, she to her laboratory; he to his. His room was filled with pieces of statuary, notebooks, paintings and antiques from the Pre-Crisis period. He entered, closed the door, and leaned against it for a minute. He told himself that he was tired. He pushed himself away from the door, walked around an easel and stared out through the window.

He looked at the flat slabs of the other lab buildings outside and smiled. A few months ago everything had seemed so well put together, now the world was falling apart. He hated the sight of the grey limestone. Gravestones. It was ugly. Ugly with mathematical regularity. The entire city was ugly with its perfect distributions, its perfect regularity, its perfect slabs of buildings filled with sane, unemotional people. A few months ago he never gave it a second thought; now, the sight of it — damn. He picked up the paint smeared piece of metal that he used for a pallet, and turned to the easel. He studied the half-finished painting. The picture was of a girl. It was a recognizable attempt at portraiture, but a failure.

In the solitude of his room he spoke aloud. "Art, says Central, is nuts."

With all his might he threw the pallet at the painting. It tore through the canvas, hit the wall, and clattered to the floor. He stared at the triangle of light that jabbed into the girl's cheek, and seizing the torn canvas, he ripped it across her face.

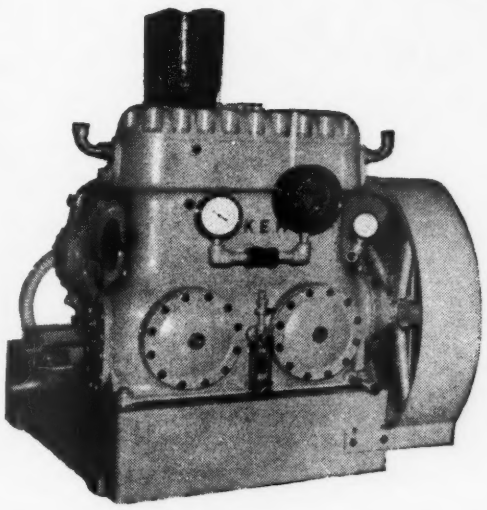
"Love, says Central, is insanity."

He kicked the easel over.

"Central says what a silly question Central says love is insanity Central says Central says the machine is insane it has no use it must be destroyed what a silly question Central says it must be destroyed it must be destroyed Central says Central says Central says it must be destroyed."

He stood shaking with the noise of the smashed easel echoing in his mind. He began to cry.

Another page for **YOUR BEARING NOTEBOOK**



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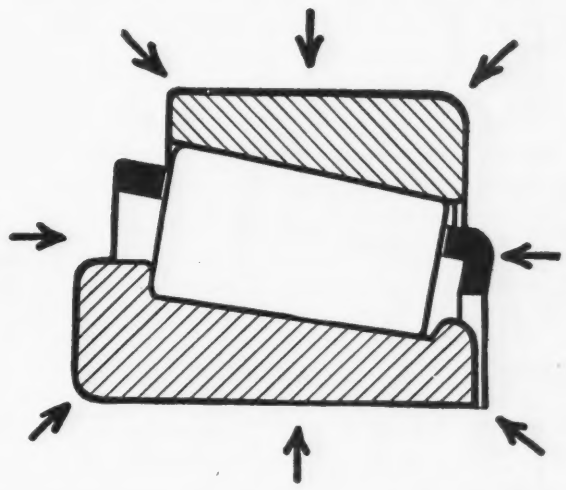

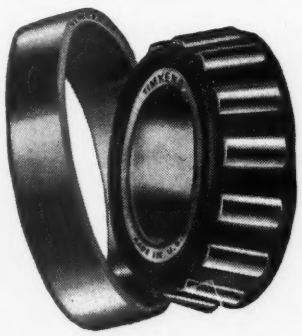

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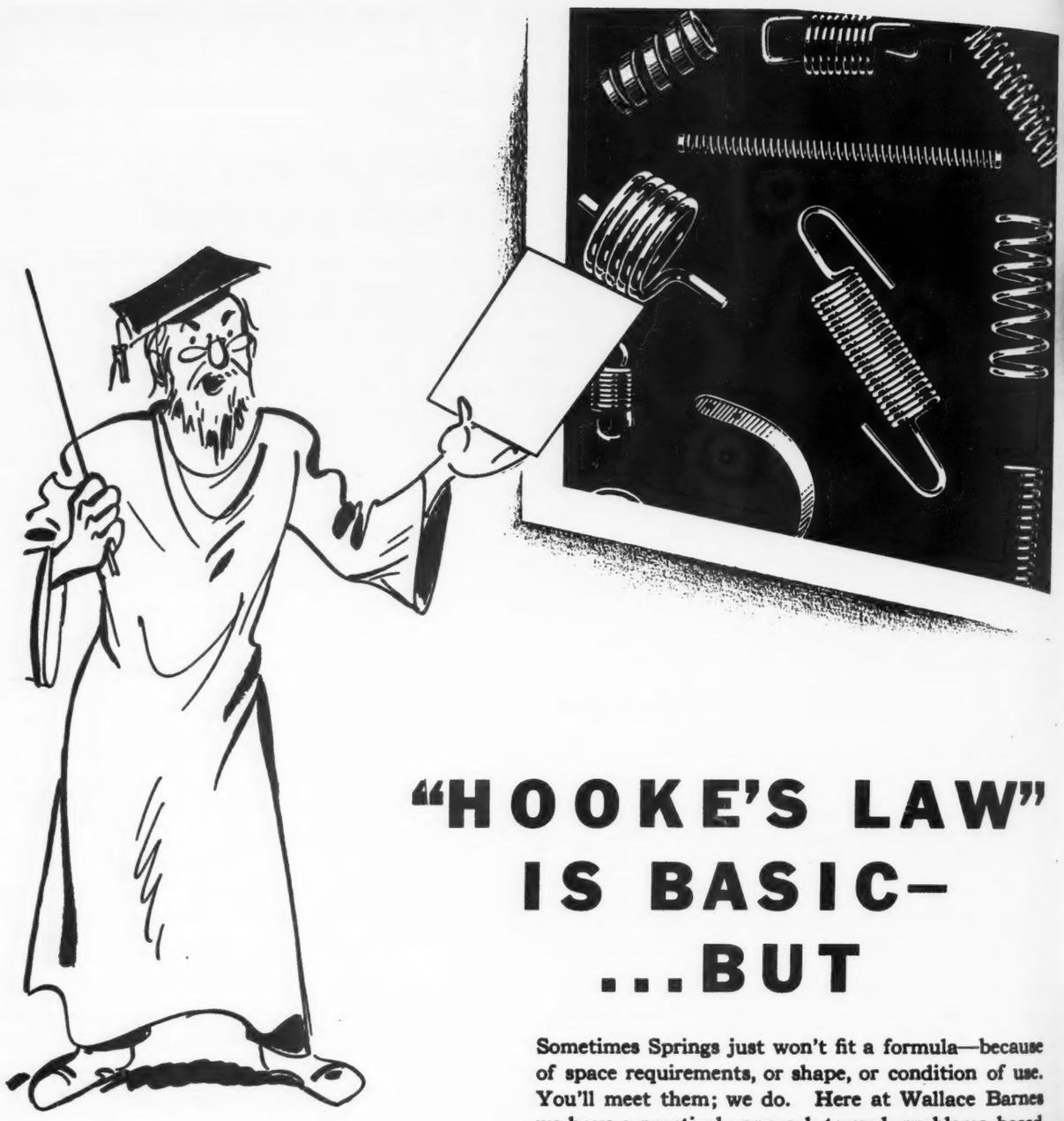

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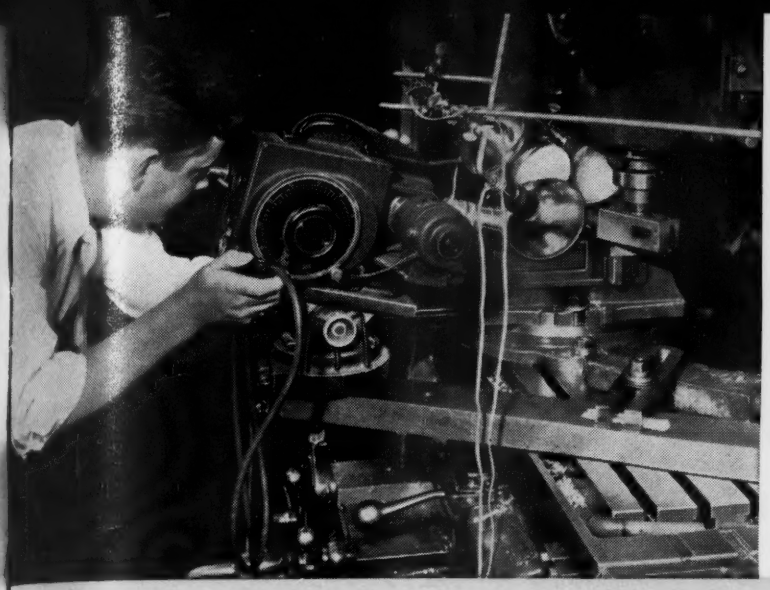

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These versatile synthetics, blended from phthalic anhydride, glycerine, and linseed, soya, or castor oil, serve the paint industry like so many faithful genii. General Electric has developed a Glyptal for almost every paint function—for adhesion, heat-resistance, arc-resistance, and humidity; for acid-, alkali-, and oil-resistance. These moderate-cost resins have excellent durability.

In exterior or interior paints, enamels, primers, and sealers, 2509 Glyptal formulations are ideal.

Master Mixers

These qualities have demonstrated Glyptal's value in coatings, both preservative and decorative, for metals, woods, paper, textiles, and in adhesives, printing inks, rubber compounds and floor coverings. The resins are recommended as specific vehicles for architectural, automotive, and industrial finishes; water-thinned paints; nitrocellulose lacquers; urea-formaldehyde enamels; aluminum paint; bulletin colors; marine paints, and in numerous other applications.

Glyptal alkyd resins are supplied in a variety of solvents so that they can be easily applied by spraying, dipping, brushing, flowing, or roller coating.

For automobile and aircraft formulations, use 2477 Glyptal.

They are compatible with a variety of pigments, and disperse and suspend them very well. Many are miscible with each other and with some varnishes and oils, making possible the formulation of numerous intermediate products.

One from Many

Glyptal alkyd resins are only one of the numerous offspring of General Electric research. Like G-E silicones, permanent magnets, and plastics—compounds as well as molded products—they are being used more and more extensively every month. Expanding production facilities, with new plants in Anaheim, California and Waterford, New York, are helping to meet the paint industry's growing needs for Glyptal. For more information on these products, write to Chemical Department, General Electric Company, Pittsfield, Massachusetts.

In paints for toys—or farm machinery—2592 Glyptal is suitable.

A message to students of chemistry from

J. R. PATTERSON

Chemicals Division, G-E Chemical Department

"The increasing awareness of the role of science in the future of every one of us will continue to stimulate opportunities for young chemists. Here at General Electric, research in synthetic resins is just one of the Chemical Department's activities that hold great promise for further development."

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